PROJECT SPECIFICATIONS

LIFT STATION REHAB – GROUP 2

SARP10 PROGRAM
CITY OF MEMPHIS

CA NO. 407904.61.0124

Project List:

2497 HANDWOOD AVENUE
4884 HIGHWAY 61
450 JACK CARLEY CAUSEWAY
5175 JONETTA STREET
5730 SARANAC AVENUE
4329 WILDWOD ROAD

DECEMBER, 2021
PREPARED BY: PICKERING FIRM, INC.

TABLE OF CONTENTS FOR TECHNICAL SPECIFICATIONS

END OF TABLE OF CONTENTS

SECTION 01501
SPECIAL CONDITIONS

1. SCOPE OF THE CONTRACT:

A. The work required under this Contract includes furnishing and paying for all necessary materials, labor, tools, equipment, and other items and construction improvements of the 450 Jack Carley Causeway sanitary sewer lift station improvements, complete in every detail, ready for the Purchaser's beneficial use as specified herein and/or indicated on the contract drawings.

2. MODIFICATIONS AND ADDITIONS TO TECHNICAL SPECIFICATIONS:

A. In the event of conflict between the TECHNICAL SPECIFICATIONS Construction Drawings, the General Provisions or Special Conditions contained herein, and/or product manufacturer's specifications the more stringent shall apply. However, all conflicts shall be brought to the attention of the INSPECTOR for approval.

B. The cost of all required material inspections and testing, including, but not limited to earthwork and concrete testing, shall be paid for by the CONTRACTOR.

C. Item No. 01501-01 Erosion Control

1. This item is not specified in the Technical Specifications.

2. Job Conditions

a. Excavation, trenching, backfilling, and grading operations to elevations as needed to meet the requirements shown on the Contract Documents, shall be done in such a manner as to cause the least amount of soil erosion and siltation.
b. Appropriate erosion and sediment control measures shall be in place before any clearing of vegetation or other earth moving operations begin.
c. Provisions required to maintain uninterrupted surface water flow shall be maintained during the work. Storm water flow in existing gutters, surface drains, and swales shall not be interrupted.
d. The Engineer shall be notified of any unexpected subsurface or other unforeseen conditions. Work shall be discontinued until the Engineer provides notification to resume work.

3. Preparation

a. Erosion and sediment control shall be in accordance with the Tennessee Water Quality Control Act of 1977, as amended, and the Federal Act Pl 92-59.
b. The Tennessee Department of Conservation Publication, Tennessee Erosion & Sediment Control Handbook, latest revision, shall be used as

a guide for construction of projects that require erosion and sediment controls to protect adjoining property and waters of the state.

4. Performance

a. The contractor shall be responsible for maintaining soil erosion control measures as necessary to prevent sediment from leaving the site. The contractor shall also be responsible for satisfying the requirements of the State of Tennessee Department of Water Pollution Control as set forth in the Tennessee Erosion and Sediment Control Handbook.
b. Whenever possible, a buffer strip of vegetation cover shall be kept adjacent to grading operations.
c. Erosion control measures shall be in place and functional before earth moving operations begin, and must be properly constructed and maintained during the construction period.
d. Staked and entrenched straw bales or silt fence shall be installed along the base of all sloped cuts and fills, on the downhill sides of stockpiled soil, and along stream banks.
e. All surface water flowing toward the construction area shall be diverted around the area as much as possible to reduce erosion potential by using beams, channels, and/or sediment traps as necessary.
f. Maintenance of erosion and sediment control methods shall be performed on a regular basis throughout the construction period and until a good vegetative cover is established over the entire disturbed area.
g. A vegetation buffer strip shall be maintained between any stream and pipe trenching. Excavated material from the trench shall not be placed between the trench and stream.
h. Trenches or pits shall be backfilled as soon as practicable to reduce erosion potential.
i. Erosion control measures shall be removed when they have served their useful purpose. The disturbed soil shall be fine graded, top soiled, and planted with permanent vegetation as soon as the construction sequence allows to prevent further potential erosion and sedimentation. Any seeded areas which are eroded shall be reworked as soon as possible.
j. The contractor shall maintain records of inspections, maintenance, and repairs as required by the State of Tennessee Department of Water Pollution Control.

5. Payment

a. Payment will be at the contract unit price for Erosion Control per Lump Sum (L.S.), which shall include all material and labor necessary to complete the item as shown on the plans, including maintenance of all erosion prevention and sediment control measures. This item also includes the materials and labor for the installation and maintenance of any other erosion control measures other than silt fence that may be

needed for erosion prevention and sediment control during the life of the project.

D. ITEM No. 01501-02 4-Inch PVC Force Main

1. This item is not specified in the Technical Specifications.

2. GENERAL

a. Installation and testing of sewage force mains and appurtenances.
b. PVC pipe and fittings.
c. Valves and appurtenances.

3. REFERENCES

a. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
b. ASTM D3139 - Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
c. ASTM F477 - Elastomeric Seals Gaskets for Joining Plastic Pipe.

4. MATERIALS

a. PVC Pipe. ASTM D2241, Cell Classification 12454-B, bearing NSF Seal; 200 PSI Pressure Rating, SDR21, IPS-O.D.
b. Fittings. ASTM D2466
c. Joints.
    1) PVC to PVC. ASTM D3139, push-on-joint with ASTM F477 elastomeric gaskets of synthetic rubber. Natural rubber will not be acceptable.
    2) PVC to Cast Iron. ANSI/AWWA C111/A21.11, mechanical joint, except gaskets shall be synthetic rubber. Natural rubber will not be acceptable. Use special transition gaskets with ASTM D2241 pipe cast iron fittings or valves.
    3) Conductive Tracer. Detection tape, 3 inches wide, aluminum foil core, 0.5 mils thick, encased in a protective, inert, plastic jacket; 5,000 psi min. tensile strength; 2.5 pounds per inch per 1,000 feet min. weight; color coded in accordance with APWA Uniform Color Code. Allen Systems “Detectatape”.

5. SUBMITTALS

a. Drawings and data including but not limited to the following:
    1) Details of joints.
    2) Gasket material.
    3) Pipe lengths

6. EXECUTION

a. EXAMINATION
   1) Inspect pipe and fittings for cracks and other defects immediately before installation. Pay particular attention to spigot ends and bells.
   2) Remove any defective pipe and fittings from the site.

b. PREPARATION
   1) Prior to laying pipe, prepare suitable bedding in accordance with manufacturers recommendations.
   2) Swab interior of the pipe to remove all undesirable material.
   3) Prepare the bell end and remove undesirable material from the gasket and gasket recess.
   4) Provide facilities for proper dewatering and for disposal without damage to adjacent property of all water removed from dewatered lines and excavations.

c. INSTALLING PIPE
   1) Use proper implements, tools and equipment to place pipe in the trench without damage.
   2) Do not drop pipe into the trench.
   3) Lay all pipe in a straight line on uniform grade with bell ends facing the direction of laying unless prior approval is obtained for reverse laying.
   4) Prevent foreign matter or dirt from entering pipe.
   5) Cut pipe for inserting valves, fittings, etc. in a neat and workmanlike manner without damaging the pipe and to leave a smooth, beveled end perpendicular to the axis of the pipe.
   6) When pipe laying is interrupted, close the open ends of installed pipe to prevent entrance of water, dirt, foreign matter or small animals. Remove all water from the trench prior to removing the closure.

d. JOINTING
   1) Push-on Joints
      i. Assemble joint as recommended by the pipe manufacturer.
      ii. Use clean gaskets.
      iii. Immediately before joint is to be assembled lubricate all joint surfaces and gaskets with manufacturer’s supplied, potable water safe, lubricant.
      iv. Store lubricant in closed containers.
   2) Mechanical Joints
      i. Assemble joint as recommended by the manufacturer.
      ii. Overtightening bolts to compensate for poor assembly will not be permitted.

e. ALIGNMENT AND GRADES
   1) Lay pipe to the alignment and grades indicated on the drawings.
   2) Pipelines intended to be straight shall be laid straight.
   3) Do not exceed maximum deflections specified by the joint manufacturer.

4) Protect pipe from lateral displacement with properly installed pipe embedment material in accordance with manufacturers recommendations.

f. INSTALLING APPURTENANCES
   1) Set all valves, fittings and other appurtenances in a neat and workmanlike manner.
   2) At each valve, bend, reducer or fitting where changes occur in pipe diameter or direction provide thrust blocks, pipe anchors or other approved means as shown on the drawings or otherwise required to prevent displacement of pipe or fittings.

g. HYDROSTATIC PRESSURE TESTS
   1) Air pressure testing of force mains is expressly prohibited.
   2) Ensure that permanent joint restraint and properly cured thrust blocking are in place before pressure testing. Restrain ends of pipe to be tested to withstand thrust developed under pressure.
   3) Provide the test water, all necessary piping connections between the line to be tested and the source of water supply, test pumping equipment, water meter pressure gage, and other equipment, materials and facilities required for the testing.

h. Test Pressures shall:
   1) Not be less than 50 psi above the working pressure at the highest point along the test section.
   2) Not exceed 200 psi.
   3) Be of at least 2-hour duration when joints are exposed and 4-hours where any joints in the line are covered or backfilled.
   4) Not drop by more than 5 psi, after the test pump is shut-down for 1-hour.

i. Pressurization
   1) Slowly fill pipe with water. Maintain flow velocity below 2 fps during filling.
   2) Apply the specified test pressure, based on the elevation of the lowest point of the line or section under test and correct to the elevation of the test gauge by means of a pump connected to the pipe.

j. Air Removal
   1) Before applying the specified test pressure, expel air completely from the pipe.
   2) If permanent air vents are not located at all high points, install corporation cocks at such points to expel air as the line is filled with water.
   3) After all the air has been expelled, close the corporation cocks and apply the test pressure.
   4) At the conclusion of the pressure test, remove the corporation cocks and plug.
   5) Dispose of test water in a manner approved by the Engineer and Owner.

k. Examination
   1) Carefully examine all exposed pipe, fittings, valves, and joints.

2) Repair or replace with sound material any damaged or defective pipe, fittings, valves, or leaking joints that are discovered and repeat the test until it is satisfactory to the Engineer.

7. PAYMENT

a. Payment will be at the contract unit price per linear foot, classified by size and type of pipe including clearing and grubbing; trenching; control of ground and surface waters; embedment; preparation of trench or embedment; placing and joining pipe; all tees, bends and fittings; backfill; finish grading; pressure testing and all Work required by the Contract Documents or necessary for a functional force main, complete in place. Measurement: By the linear foot on the basis of pipeline stationing classified by size and type of pipe, along the longitudinal centerline of the pipe, after installation, from the centerline of the beginning and ending structure.

E. Item No. 01501-03 Miscellaneous Valves

1. This item is not specified in the Technical Specifications.

2. GENERAL

a. Miscellaneous valves and appurtenances except were specific requirements are stipulated in other sections.
b. See Section 02530 for Ductile Iron Pipe.

3. REFERENCES

a. ANSI/AWWA C111/A21.11 - Rubber Gasket Joints for Ductile Iron Pressure Pipe.
b. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
c. ANSI B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.

4. PRODUCTS

a. Manual Operators: All valves shall be provided with manual operators. Unless otherwise specified or indicated on the drawings, each manual operator shall be equipped with an operating handwheel.
b. Wrench Nuts: Wrench nuts shall be provided on all buried valves, on all valves which are to be operated through floor boxes, and where indicated on the drawings. Unless otherwise directed by the Owner, all wrench nuts shall comply with Section 4.11 of ANSI/AWWA C509. Not less than two operating keys shall be furnished for operation of the wrench nut operated valves.

c. Lever Operators: Unless otherwise shown or specified, plug and ball valves shall be lever operated. Two suitable operating levers shall be furnished for each type and size of lever operated valve.
d. Rotation: Unless otherwise required by the Owner, the direction of rotation of the wheel, wrench nut, or lever to open the valve shall be to the left (counterclockwise). Each valve body or operator shall have cast thereon the word “OPEN” and an arrow indicating the direction to open.
e. Length Tolerance: Actual length of valves shall be within 1/16 inch (plus or minus) of the specified or theoretical length.
f. Ends: Unless otherwise specified or shown on the drawings, all 3 inch or larger buried valves shall have push-on or mechanical joint ends, all other 3 inch or larger valves shall have flanged ends, and all 2½ inch or smaller valves shall have threaded or solder ends as required by the piping system in which the valve is to be installed. Unless otherwise indicated on the drawings, flange diameter and drilling shall conform to ANSI B16.1, Class 125 or ANSI B16.5, Class 150. Push-on and mechanical joints shall conform to ANSI/AWWA C111/A21.11. Wafer style valves shall be designed for installation between ANSI Class flanges.
g. Unions: A union or flanged connection shall be provided within 2 feet of each threaded end valve unless the valve can be otherwise easily removed from the piping.
h. Shop Painting: All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop painted for corrosion protection. The valve manufacturer’s standard paint will be acceptable provided it is functionally equivalent to the specified paint.

5. VALVES AND BOXES

a. Gate Valve:
    1) Gate Valves 3 inch and larger. Resilient-seated conforming to ANSI/AWWA C509.
    2) Inside structures. Rising stem type.
    3) Buried or submerged. Non-rising stem type with O-ring stem seals.

b. Check Valve:
    1) Check valves 3 inch and larger. Unobstructed waterway, quick closing, spring loaded, horizontal swing type with iron bodies, flanged ends, bronze trim, stainless steel hinge pins having both ends extending through bronze-bushed bearings and outside stuffing boxes with grease lubricated packing or O-ring seals.
    2) Flanges: Flat faced ANSI B16.1, Class 125

c. Plug Valve:
    1) Three-way, non-lubricated, tapered type with semi-steel body and flanged end connections drilled to 125 pound standard, a drip tight shutoff plug mounted in stainless steel bearings, a resilient facing bonded to the sealing surface and operated with a single lever actuator providing lift, turn and reseat action with a lever locking device to hold the plug in the desired position.

d. Pump Station Air Release Valves:
    1) Cast iron or stainless steel with a minimum 3-inch diameter clean-out port and field adjustable for varying discharge heads and visible indication of valve closure as recommended by the package pump station manufacturer.

e. Tapping Sleeves:
    1) Flanged outlet type with mechanical joint ends at each end of the run.

f. Tapping Valves:
    1) ANSI/AWWA C509, with exception of valve ends and modifications necessary for tapping service; flanged inlet end designed, faced, and drilled for attachment to the outlet flange of the tapping sleeve; outlet end with a tapping flange for attachment of a standard drilling machine and with a mechanical joint bell end for connection of the branch line.

g. Valves Boxes:
    1) Buried Valves 4 feet or less in depth: Slide type valve box, cast iron, extension sleeve type with no more than one extension, 5 inches minimum inside diameter and 3/16 minimum thickness at any point, with suitable cast iron bases and covers.
    2) Buried Valves greater than 4 feet deep: 6 inch cast iron pipe section with cast iron cover, extend pipe shaft from the valve to 5 inches inside the valve box cover.
    3) Covers shall have cast thereon the designation of the service for which the valve is used. i.e. water, sewer, etc.
    4) Coat all parts of valve boxes, bases, and covers by dipping in asphalt varnish.

6. EXECUTION

a. Set valves and valve boxes plumb.
b. Place valve box directly over the valve it serves.
c. Bring top of valve box flush with the finished grade.
d. After placing valve box in proper position, fill around each valve box and thoroughly tamp earth fill on all sides of the box.

7. PAYMENT

a. Payment will be at the contract unit price per each tap, valve, and valve box assembly, classified by size and type of pipe including clearing and grubbing; trenching; control of ground and surface waters; embedment; preparation of trench or embedment; placing and joining pipe; all tees, bends and fittings; backfill; finish grading; pressure testing and all Work required by the Contract Documents or necessary for a tap, valve, and valve box assembly, complete in place.

F. Item No. 01501-04 Wetwell and/or Sewer Manhole Abandonment

1. This item is not specified in the Technical Specifications.

2. GENERAL

a. The abandonment of existing wetwells and/or sewer manholes, in place, shall be in conformance with the details and notes provided on the plans.

3. PAYMENT

a. Payment will be at the contract unit price per each wetwell and/or sewer manhole abandoned, measured in place, based on the dimensions and depths indicated on the plans, including clearing and grubbing; control of ground and surface waters; placing and compacting of materials as indicated on the plans; removal of materials as indicated on the plans, disposal of materials, finish grading; and all Work required by the Contract Documents or necessary for the wetwell and/or sewer manhole abandonment, complete in place.

G. Item No. 01501-05 Gravel Surface at Pump Station Sites

1. This item is not specified in the Technical Specifications.

2. GENERAL

a. Furnish gravel surface course to the extent and thickness indicated on the plans.
b. Except as otherwise directed by the Owner, all gravel base will be as indicated on the plans.

3. PAYMENT

a. Payment will be at the contract unit price per cubic yard of gravel, measured in place, based on the dimensions and depths indicated on the plans, including clearing and grubbing; control of ground and surface waters; preparation of subgrade; placing and compacting of gravel; finish grading; and all Work required by the Contract Documents or necessary for the gravel surface installation, complete in place.

H. Item No. 01501-06 Flood Light and Pole

1. This item is not specified in the Technical Specifications.

2. GENERAL

a. Furnish a standard flood light and wood pole at the lift station site as indicated on the plans.

3. PAYMENT

a. No separate payment will be made for the flood light and wood pole installation at the pump station site. All costs associated with the flood light and pole assembly will be included in the Wetwell Mounted Pump Station lump sum unit price, including but not limited to: clearing and grubbing; control of ground and surface waters; preparation of subgrade; installation of wood pole; conduit, wiring, and all electrical connections; and all Work required by the Contract Documents or necessary for the flood light and wood pole installation, complete in place.

END OF SECTION 01501

SECTION 01551
TRAFFIC CONTROL FOR CONSTRUCTION WORK ZONES

PART 1 - SCOPE

This work shall consist of furnishing, erecting, illuminating, handling, and maintaining all construction signs (warning, regulatory, and guide), barricades, and other traffic control devices designated for installation at locations specified by the Plans or the approved Traffic Control Plan, or directed or approved by the Purchaser for the purpose of handling traffic safely through construction work zones. This work shall include the provision of flaggers or special measures necessary to assure the handling of traffic safety through construction work zones.

PART 2 - MATERIALS

2.01 GENERAL REQUIREMENTS

A. All signs, barricades, markers, lights, and other traffic control devices for use in construction work zones shall meet the requirements of Part VI of the Tennessee Manual on Uniform Traffic Control Devices (MUTCD). Materials used in the fabrication, construction, and installation of the construction signs, barricades, and other traffic control devices shall conform to the requirements of the MUTCD, and the City of Memphis Standard Construction Specifications.

B. Items are not required to be new. Used items may be acceptable provided the following conditions are met:

1. Units are in good repair, clean, and structurally sound.

2. Reflective sheeting on any unit is clean and in good repair.

3. All legends and messages are sharp, clean, and legible.

4. Reflectivity of said units during the hours of darkness shall provide acceptable, clean and uniform delineation without dead spots.

C. No test reports are required, but the Purchaser will visually inspect all units and accessories for compliance with the various dimensional and material stipulations noted before approving their use in the work. The approval of any unit for use is subject to satisfactory field performance and does not preclude the Purchaser ordering replacements for deteriorated, damaged or otherwise unsatisfactory performance of units; said replacements for these previously approved units shall be without additional compensation.

2.02 SUBMITTALS

1. A Traffic Control Plan shall be submitted to the Program Manager, including the following items:

- Outline of permit acquisition procedure for lane closures.

- Methods for proper signing and barricades, which comply with local requirements and the City.

- Major streets (e.g. Shelby County Principal Arterial & Minor Arterial) requiring a City approved permit if taking a lane for mobile operations, secured through Traffic Control Plan submittal to the City and signed by a TN P.E. The City requires a two-week lead time for permit processing.

- The Contractor will be required to deliver a sample primary/arterial road Traffic Control Plan for review by the City.

- If the City determines that the nature of the work operation or the type of road in which the Contractor is working requires a permit, the Contractor will be required to modify the sample Traffic Control Plan to obtain a permit from the City.

- For everywhere else where a permit is not required, the Contractor shall develop, provide, and implement a Traffic Control Plan for all mobile operations in accordance with standard MUTCD specifications.

- The Contractor is also responsible for acquiring all necessary disposal and/or landfill site permits required to perform this work.

- Railroad Rights of Way: The Contractor shall notify the Program Manager when work or access to manholes and sanitary sewers lie within the 25 feet railroad easement, as measured by 25 feet outside the nearest rail of the tracks. To access sewer facilities within the 25 feet of the railroad right of way, the Contractor shall contact 48 hours in advance the Program Manager, who will alert the City's Zone Construction Inspector to coordinate individual railroad direction and guidance.

2.03 CHANNELIZING AND WARNING DEVICES

Reflectorization of channelizing and warning devices shall be accomplished using materials meeting the requirements of the City of Memphis Standard Construction Specifications.

A. Traffic Cones.

Traffic cones and tubular markers shall be a minimum of 18 inches in height with a broadened base and shall be made of materials to withstand impact without damage to themselves or to vehicles. Orange shall be the predominant color on cones and tubular markers. For nighttime use they shall be reflectorized or equipped with lighting devices for maximum visibility. The design of traffic cones and tubular markers shall be according to the requirements of Section 6C of the MUTCD.

B. Vertical Panels.

Vertical panels used as channelizing or warning devices shall be 8 to 12 inches in width and a minimum of 24 inches in height. They shall be orange and white striped and reflectorized. The design or vertical panels shall be according to Section 6C of the MUTCD.

C. Drums.

Drums used for traffic warning or channelization shall be approximately 36 inches in height and a minimum of 18 inches in diameter. The markings shall be horizontal, circumferential, orange and white reflectorized stripes meeting the requirements of Section 6C of the MUTCD.

D. Barricades.

A barricade is a portable or fixed device having from one to three rails with alternate orange and white reflectorized stripes used to control traffic by closing, restricting, or delineating all or a portion of the right-of-way. Barricades shall be of one of three types: Type I, Type

II, and Type III. The characteristics and design of each type of barricade shall be according to Section 6C of the MUTCD.

E. High Level Warning Devices.

High level warning devices are used to supplement other controls and warning devices and are designed to be seen over the top of preceding vehicles. They shall consist of an orange diamond and three flags. The lowest point of all three flags shall be no less than 8 feet above the roadway. The design shall be according to the requirements of Section 6C of the MUTCD.

F. Warning Lights.

As used herein, warning lights are portable, lens directed, enclosed lights. The color of the light emitted shall be yellow. They may be used either in a steady burn or flashing mode. Warning lights shall be in accordance with the current requirements of ITE Standard for Flashing and Steady Burn Warning Lights (Table 01551-1) and Section 6E of the MUTCD.

TABLE 01551-1

WARNING LIGHTS

	Type A Low Intensity	Type B High Intensity	Type C Steady Burn
Lens Directional Faces	1 or 2	1	1 or 2
Flashing Rate per Minute	55 to 75	55 to 75	Constant
Flash Duration[1]	10%	8%	Constant
Minimum Effective Intensity[2]	4 Candelas	35 Candelas	
Minimum Beam Candle Power[2]			2 Candelas
Hours of Operation	Dusk to Dawn	24 hrs/day	Dusk to Dawn

[1] Length of time that instantaneous intensity is equal to or greater than effective intensity.
[2] These values must be maintained within a solid angle 9^0 on each side of the vertical axis and 5^0 above and 5^0 below the horizontal axis.

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 GENERAL REQUIREMENTS.

A. A Traffic Control Plan shall be developed by the or Subcontractor and approved by the Purchaser before any road, street, or highway, or any section or lane thereof is closed to traffic and construction operations that will for any reason render the roadway generally unsuitable for use of the traveling public are started. Where the Plans and Contract Documents for projects involving roads, streets, and highways do not specify a Traffic Control Plan, and where so required by the Contract Documents, the Subcontractor shall prepare and submit to the Purchaser for approval a Traffic Control Plan for the project which shall include, but not be limited to, signing; application and removal of pavement markings; construction; scheduling;

closure of streets or lanes; detours; methods and devices for delineation and channelization; placement and maintenance of devices for delineation and channelization; roadway lighting; traffic regulations; and surveillance and inspection. The Traffic Control Plan shall define in detail the sequence of construction and the proposed number, type, color, size, and placement of construction traffic control devices for each construction phase, all in accordance with Part VI of the Tennessee Manual on uniform Traffic Control Devices for Streets and Highways (MUTCD).

B. The Subcontractor shall designate or otherwise provide personnel to furnish continuous surveillance over his traffic control operations. This designee will also be available at night to respond to calls involving damage to barricades, lights, signs, and similar items, either through vandalism or traffic accident. The Subcontractor shall make known the name of the person providing the surveillance at the preconstruction conference.

C. All traffic control devices necessary for the first stage of construction shall be properly placed and in operation before any construction is allowed to start. When work of a progressive nature is involved, such as resurfacing a road under traffic, the necessary signs shall be moved concurrently with advancing operation.

D. All construction signs shall be erected such that all supports are vertical, sign panels generally perpendicular to the travel way and legends horizontal so that they effectively convey the intended message. These signs shall be mounted on stationary or temporary supports as directed by the Purchaser and dependent on the type work being performed. In general, work being performed at spot locations and of short duration will necessitate the use of temporary supports properly weighted for stability. If the construction signs are not to be lighted, the supports shall not extend above the top edge of the sign panel.

E. The location, horizontal and vertical placement with respect to the pavement, legends, sheeting, dimensions, and spacing of supports of warning signs, barricades, and other traffic control devices shall be as required by the Plans, the Traffic Control Plan, the MUTCD, and as directed or approved by the Purchaser. The Subcontractor must advise and have the approval of the Purchaser prior to installing or removing traffic control devices from the project.

F. During periods of nonuse, construction signs and other devices shall be removed from the work area, or covered with opaque material, or otherwise positioned so they do not convey their message to the traveling public. If covered, the covering material shall be installed in accordance with the Plans and in such manner that no damage will occur to the sign panel during installation. Covering material shall be maintained in a neat manner during its use.

G. All construction signs, barricades, and other devices which require lighting, as designated by Plans or directed by the Purchaser, shall be provided with warning lights or electric incandescent or fluorescent lighting. It will be the Subcontractor’s responsibility to install electric lighting in a safe manner and in accordance with the latest edition of the National Electrical Code, National Electrical Safety Code, and/or all local codes. The Subcontractor will be responsible for investigating, procuring, and bearing the expense of a continuous power source whether by battery, generator, or commercial A.C. supply.

H. Flaggers with proper attire and flags shall be provided when ordered by the City or Purchaser or when the Subcontractor deems flaggers necessary to safely handle traffic through the construction zone. Flaggers shall wear either an approved uniform or a vest of fluorescent orange color and be equipped with either a red flag of fluorescent material or a paddle with a reflective red and white STOP sign on one side and a reflective orange and black SLOW sign on the other side. Flaggers are considered a general requirement of all traffic control schemes and no direct payment will be made for such.

I. If at any time the City or Purchaser determines that proper provisions for safe traffic control are not being provided or maintained, he may order suspension of the work until the proper level is achieved. In cases of serious or willful disregard for safety of the public or his employees by the Subcontractor, the Purchaser may proceed forthwith to place the traffic control measures in proper condition and deduct the cost thereof from payment due or becoming due the Subcontractor.

3.02 MAINTENANCE

A. The Subcontractor shall assume full responsibility for the continuous and expeditious maintenance of all construction warning signs, barricades, and other traffic control devices. Maintenance shall include but shall not be limited to replacement of sign panels, barricades, and other devices which in the opinion of the Purchaser are damaged or deteriorated beyond effective use; replacement of broken supports; plumbing of leaning signs; cleaning of dirty signs, barricades, and other devices; repair of defaced signs; and replacement of stolen items.

B. All items used for traffic control shall be generally maintained in its original placement condition and such maintenance will be considered a part of the original installation cost. Failure to maintain all traffic control devices in such manner as to provide adequate continuous safety to the public will be cause for action by the Purchaser as noted in Specification Section 01551 Paragraph 3.01.I.

PART 4 – MEASUREMENT

Each accepted item related to traffic control for construction work zones shall be measured as described herein. All work not described herein shall be considered incidental to the provision of traffic control for construction work zones.

4.01 TRAFFIC CONTROL PLAN.
Development of a Traffic Control Plan for the construction work zone will be paid for on a lump sum basis and no measurement will be made.

4.02 TRAFFIC CONTOL DEVICES FOR CONSTRUCTION WORK ZONES.
Furnishing, erecting, and maintaining traffic control devices and other incidentals and personnel required for handling traffic safely through construction work zones will be included in the lump sum payment for Traffic Control Plan and no measurement will be made.

PART 5 – PAYMENT

Payment for accepted work shall be made at the appropriate contract price which shall be payment in full for all work required under the pay item. Payment will be made under the pay items listed at the end of this Specification Section.

5.01 TRAFFIC CONTROL
Payment will be made for the work completed and accepted by the Purchaser at the contract lump sum price, which shall be full compensation for development of a Traffic Control Plan; for furnishing, erecting, illuminating, handling, and maintaining all construction signs (warning, regulatory, and guide), barricades, and other traffic control devices designated for installation at locations specified by the Plans, the Traffic Control Plan, or directed or approved by the Purchaser for the purpose of handling traffic safety through construction work zones for the duration for the project. Payment shall also include provision for flaggers or special measures necessary to assure the handling of traffic safely through construction work zones.

1.01 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
01551-6.01	TRAFFIC CONTROL	Lump Sum

END OF SECTION 01551

SECTION 01610
BASIC PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE

A. All materials and permanently installed equipment (for example, traffic signalization equipment, sewer pumps, and other such items) furnished by the Subcontractor for the Work shall conform to the requirements of the Plans and Contract Documents, including the applicable City of Memphis Standard Construction Specifications and Design Standards.

B. Throughout the entire Project, all units of any one item of installed equipment shall be of the same manufacture and model unless otherwise approved by the Purchaser.

PART 2 PRODUCTS

2.01 MATERIALS & EQUIPMENT

A. Equivalent Materials and Equipment

1. The General Conditions allows for the substitution of equivalent materials and equipment, with the written approval of the Purchaser.

2. Reference to a particular product by manufacturer, trade name, or catalog number establishes the quality standards of materials and equipment required for the Work. It is not intended to exclude products equivalent in quality and similar in design. Whenever any article, material, or equipment is identified by using the name of a manufacturer or vendor, the term “or approved equal” if not inserted shall be implied.

3. If the Subcontractor proposes to furnish materials or supplies other than those specified, he shall furnish complete descriptive data, including performance capabilities, specifications, and other data as required in the Contract General Conditions. The provisions of this substitution of materials shall not relieve the Subcontractor of the responsibility of meeting the requirements of the Plans and Contract Documents. All materials must be approved by the Purchaser before any installation will be permitted.

B. List of Major Materials an Equipment

1. The Subcontractor shall submit to the Purchaser for approval, with due promptness after award of Contract but in no case later than at the preconstruction conference, a list of major equipment and materials which he proposes to provide. The list shall include in sufficient detail to identify the materials, the name of the manufacturer’s model number of all material that is identified on the Plans or in the Contract Documents, including catalog literature for standard equipment and detailed scale drawings of any nonstandard or special equipment and of any proposed deviation from the Plans. A signed statement shall accompany this list stating that materials and equipment are in exact accordance with Project specifications. No charge shall be made to the Purchaser for any materials or equipment purchased, labor performed, or delay to the Work prior to approval of materials by the Purchaser.

C. Source of Supply

1. The source of supply for each material to be supplied by the Subcontractor shall be subject to approval by the Purchaser before delivery is started.

PART 3 EXECUTION

A. Samples and Testing

1. Representative samples of materials included for incorporation in the Work shall be submitted to the Purchaser for his examination and/or testing when so specified or requested.

2. All testing of materials shall be made in accordance with the standard methods of testing of the ASTM, AASHTO, NEMA, ITE, or other applicable standard specifications.

PART 4 MEASUREMENT & PAYMENT

4.01 PROPOSAL QUANTITIES

A. The quantities appearing in the Proposal Sheet(s) of the Proposal are approximate and are proposed and shown for the comparison of bids and award of a Contract. The Purchaser does not guarantee or assume any responsibility that the quantities indicated on the Plans or in the Proposal will hold true and accurate in the construction of the Project. The Subcontractor shall not plead deception or misunderstanding because of variation from these quantities. Unless otherwise provided in the Contract Documents, payment to the Subcontractor will be made only for the actual quantities of Work performed and accepted, and materials and equipment furnished and placed in accordance with the Contract. The Subcontractor is reminded of the limitation provided by Section 838 of the Charter of the City of Memphis which limits the total amount of the increase in the Contract Price, for any reason, to ten (10) percent of the original Contract award amount. There are no specific limitations on the amount by which the Contract Price and project quantities may be decreased.

4.02 MEASUREMENT OF QUANTITIES

A. All Work completed under the Contract will be measured by the Purchaser according to United States standard measure.

B. The term “ton” will mean the short ton consisting of 2,000 pounds.

C. The determination of quantities for specific items will be made as set for the in the subsection titled “Measurement” under the applicable Sections of the Standard Construction and Material

D. Specifications hereof, or of other Specifications provided for the Work.

E. Longitudinal and transverse measurements for surface area computations will be to the exact dimensions shown in the horizontal plane on the Plans or as ordered in writing by the Purchaser.

F. Structures will be measured according to the lines and exact dimensions shown on the Plans or as altered to fit field conditions by direction to the Purchaser.

G. In all cases where measurement of materials is based on certified weights, the Subcontractor

shall furnish the Purchaser certified weigh bills showing the net weight of materials received in each shipment. In no instance will the Purchaser pay for materials in excess of the amounts represented by the certified weigh bills.

H. When certified scale weights are not used for measurement, all materials which are measured or proportioned by weight shall be weighed on accurate, approved scales, by competent, qualified personnel, at locations designated by the Purchaser.

I. Trucks used to haul material being paid for by weight shall be weighed empty at such times as the Purchaser directs, and each truck shall bear a plainly legible identification mark.

J. Measurements for payment will be made to the nearest fractional units specified below, unless otherwise specified herein or in the Contract Documents for the project.

Unit of Measurement	Nearest Unit
Linear Foot	0.1 LF
Square Foot	0.1 SF
Square Yard	0.1 SY
Ton	0.1 Ton
Cubic Yard	0.01CY
1,000 SF Unit	0.1 Unit

END OF SECTION 01610

SECTION 02230
SITE CLEARING

PART 1 – SCOPE

1.01 This work shall consist of clearing and grubbing, removal, and disposal of all vegetation and debris within the limits of the rights-of-way and easement areas. It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes, and pits; the preservation from injury or defacement of all vegetation and objects designated to remain; and all necessary replacement of fences, trees, hedges, shrubs, and flowers.

PART 2 – EQUIPMENT

2.01 All equipment for the satisfactory performance of the Work shall be on the project and approved before the Work will be permitted to begin.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 CLEARING AND GRUBBING

A. The Purchaser will establish rights-of-way lines and construction limits. All trees, shrubs, edges, fences, and other items to remain shall be as indicated on the Plans or as directed by the Purchaser.

B. The rights-of-way shall be cleared of all vegetation and debris except items designated to remain. All other trees, stumps, roots, brush, hedges, and other protruding obstructions within the excavation area shall be completely grubbed. In embankment areas, sound undisturbed stumps and roots which will be a minimum of five (5) feet below subgrade or slope of embankment will be allowed to remain in place provided undercutting or other corrective measures are not stipulated in the plans or directed by the Purchaser and providing stumps do not extend more than six (6) inches above the ground surface. If excavation is not required, the area shall be grubbed to a minimum depth of six (6) inches below existing grade to remove grass, roots, and other organic material.

C. Low hanging branches and unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed by the Purchaser. Tree limbs and branches shall be trimmed to provide twenty (20) feet vertical clearance over the entire right-of-way. All trimming shall be done by skilled workmen in accordance with good tree surgery practices, and cut or scarred surfaces of trees or shrubs to remain shall be treated with an approved asphalt base paint prepared especially for tree surgery.

D. Within embankment areas, all depressions resulting from grubbing operations shall be backfilled with suitable material and left uniform. All depressions in excavation areas below subgrade elevation shall be backfilled with suitable material and compacted in accordance with the provisions of Specification Section 02530.

E. When specified on the Plans or Right-of-Way Agreement or so directed by the Engineer, all fences removed for construction purposes shall be replaced with salvaged existing materials or with acceptable in-kind new materials to enclose the original enclosed area as nearly as possible and tie back to the old fence.

3.02 DISPOSAL OF DEBRIS

A. All material from removal of structures and obstructions except salvaged items shall be disposed of off the Project and it shall be the Contractor’s responsibility to secure any permits necessary for the disposal.

PART 4 – MEASUREMENT

4.01 A. This item will be paid from a lump sum basis and no measurement will be made.

PART 5 – PAYMENT

5.01 Payment will be made for the work, completed and accepted by the Purchaser, at the contract lump sum price, which price will be full compensation for clearing and grubbing vegetation; removal and disposal of vegetation, debris, backfilling of depressions below subgrade elevation, protection of trees to remain; restoration of fences, trees, hedges, shrubs, flowers, or other growth as required; and moving salvageable materials to designated storage locations in accordance with the stipulations and provisions of the contract.

5.02 Payment will be made under:

Item No.	Pay Item	Pay Unit
02230-01	Clearing and Grubbing	Lump Sum

END OF SECTION 02230

SECTION 02530
SEWER PIPE INSTALLATION

PART 1 - SCOPE

1.01 This Work shall consist of the construction of sanitary sewers, siphons, service connections, and/or the removal & replacement of existing sanitary sewers and service connections of the kinds and dimensions shown on the Plans, stipulated in Contract Documents, or as directed by the Purchaser. The construction shall be accomplished by these Specifications and in conformity with the lines, grades, and details shown on the Drawings or established by the Purchaser. The Subcontractor shall perform all work necessary to complete the Contract with the best modern practice. Without specifications that state the quality of any work, the Subcontractor is required to perform such items using first-quality construction. Unless otherwise provided, the Subcontractor shall furnish all material, equipment, tools, labor and incidentals necessary to complete the Work.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIAL

A. Construction Material

1. All material furnished by the Subcontractor shall be new, high quality and free from defects. Previously used material in acceptable condition may be used for bracing, forms, false work, and similar uses. Material not conforming to the requirements of the Specifications shall be considered defective and will be removed immediately from the site.

B. Higher Strength Pipe

1. The Subcontractor may substitute a higher strength pipe of the same type as that specified subject to the approval of the Purchaser.

C. Qualifications of Manufacturers

1. Pipe for sanitary sewers shall be the standard product of an established, reputable manufacturer made in a permanent plant. Suppliers for each material to be used by the Subcontractor shall be subject to approval by the Purchaser. No material shall be delivered until the manufacturer and product have been approved by the Purchaser. For any construction project, pipe and appurtenances for each pipe material shall be the product of a single manufacturer having a minimum of 10 years domestic experience producing the type of pipe supplied.

D. Material Inspection and Testing

1. Representative samples of material intended for incorporation in the work shall be submitted for examination when so specified or requested. All material to be used in the work shall be sampled, inspected, and tested by current ASTM specifications, or other standard specifications approved by the Purchaser. The Subcontractor shall furnish the Purchaser with three copies of certified reports from a reputable testing laboratory showing the results of the tests carried out on representative samples of material to be used on the Project. Each length of pipe delivered to the project shall show the laboratory's stamp. The performance or cost of all testing is the responsibility of the Subcontractor.

2. The Subcontractor shall notify the Purchaser before any deliveries of material and shall

make whatever provisions are necessary to aid the Purchaser in the inspection and culling of the material before installation.

E. Storage

1. The Subcontractor shall provide and maintain storage facilities and exercise such measures to maintain the specified quality and fitness of material to be incorporated in the work. The interior and sealing surfaces of the pipe, fittings, and adapters shall be kept free from dirt and foreign matter. PVC pipe, fittings, and adapters stored outside and exposed to sunlight shall be covered with an opaque material with proper ventilation. All precautions taken to ensure safe storage of materials shall be the responsibility of the Subcontractor.

F. Polyvinyl Chloride (PVC) Gravity Pipe and Fittings (6-15 inch Diameter)

1. All PVC gravity pipe and fittings 6-15 inches in diameter shall be solid wall PVC; no profile wall PVC pipe is allowed for pipes 15 inches or less in diameter. PVC solid wall pipe and fittings for gravity sewer applications shall conform to the requirements of ASTM D 3034. The standard dimension ratio (SDR) shall be SDR 26 (Type PSM). PVC resin shall conform to ASTM D 1784 cell class 12454C. A different cell class shall be allowed only if the material meets the requirements of a superior cell class than 12454C. 6-inch diameter PVC pipe shall only be used for service laterals. Fittings for PVC gravity sewer pipe shall be fabricated from PVC meeting the respective ASTM PVC pipe standard for molded or extruded PVC. The wall thicknesses of the waterway and bell of fittings shall be no less than the respective minimum thicknesses for the equivalent pipe. All fittings shall be compatible with the pipe to which they are attached.

2. All PVC gravity pipe joints shall be gasketed bell and spigot push-on type conforming to ASTM D 3212, unless directed otherwise in these Specifications. Gaskets shall be part of a complete pipe section and purchased as such. Lubricant shall be as recommended by the pipe manufacturer.

G. Polyvinyl Chloride (PVC) Profile Pipe and Fittings (18-36 inch Diameter)

1. All 18-36 inch diameter PVC sewer pipe and fittings shall be designed and manufactured in accordance with ASTM F 679, F 794, F 949, or F 1803. All PVC sewer pipe and fittings shall be manufactured from PVC resin with a cell classification of either 12454C or 12364C as defined in specification ASTM D 1784. The pipe shall be furnished complete with gaskets, fittings, lubricant, etc. as required for proper installation and completion of the line. The minimum pipe stiffness at 5% deflection shall be 46 psi when tested in accordance with ASTM D 2412 and as specified in ASTM F 679, F 794, F 949, or F 1803, as applicable. Samples of the type of pipe to be used shall be tested in accordance with ASTM D 2412. Impact tests shall be conducted in accordance with ASTM D 2444 and shall comply with ASTM F 679, F 794, F 949, or F 1803. Tests shall be conducted by the manufacturer in the presence of the Purchaser's Resident Project Representative, unless otherwise directed by the Purchaser. The Owner and Purchaser will have the right to make unannounced visits to the pipe manufacturer's facility to inspect the manufacturing process.

2. All joints shall be the bell and spigot type and conform to ASTM D 3212. Gaskets shall meet ASTM F 477. All bells shall be formed integrally with the pipe and shall contain a factory installed elastomeric gasket which is positively retained. No solvent cement joints shall be permitted in field construction.

3. The pipe manufacturer shall furnish to the Purchaser a notarized certificate(s) of inspection stating that each piece of pipe used on this project was made and tested in accordance with these specifications.

4. All pipeline material shall be generically the same throughout the project with the permissible exception of utilizing different material for piping used for tie-ins of smaller lines, or as noted on the Drawings or as approved by the Purchaser.

H. Glass Fiber Reinforced Polymer Mortar Pipe and Fittings (up to 72 inch Diameter)

1 Pipe shall meet the requirements of ASTM D 3262 - Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe. The pipe shall be manufactured to form a dense, non-porous, corrosion-resistant, composite pipe that is resistant to corrosion from hydrogen sulfide and other corrosive materials normally found in sewerage systems, all without the use of special HDPE or PVC liners.

2 Minimum acceptable nominal length for joints of pipe shall be 20 feet except where field conditions require otherwise.

3 Design: The design of the pipe shall comply with all requirements of the latest revision of ASTM D - 3262 for non-pressure (gravity) flow conditions. The pipe shall also be designed for a variable depth of cover as shown on the profile; the maximum trench loading that can occur on an empty pipe after backfill is in place; and a live load equal to the AASHTO HS20 loading or the minimum live load as specified in the latest revision of ASTM D - 3262, whichever gives the greater live load.

4 Resin Systems: These shall be only polyester resin systems with a proven history of satisfactory performance in sewage applications. Historical data shall have been acquired from a composite material of similar construction and composition.

5 Glass Reinforcements: Reinforcing glass fibers used in the manufacture of the pipe shall be of the highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.

6 Interior Lining: All interior surfaces of the pipe shall be lined with a fiberglass reinforced polyester lining as a part of the manufacturing process.

7 Joints: The pipe shall be field connected with fiberglass sleeve couplings that utilize full face elastomeric sealing gaskets of EPDM rubber compound, providing a zero leakage joint. The coupling shall be factory assembled to one end of the pipe. Each joint shall be pressure tested after installation.

8 Tests and Examinations: Tests, in-process and final examinations shall be performed by the manufacturer, or an independent testing laboratory approved by the Engineer, in accordance with the latest revision of ASTM D 3262, in order to assure conformance. All instruments, gauges, and other testing and measuring equipment shall be of the proper range, type and accuracy to verify conformance and test equipment shall be checked at least annually against calibrated and certified test gauges and instruments. The Engineer shall have access to all records of tests and inspections related to the manufacture of the pipe, and, without notice to the manufacturer, shall also have the right to witness the manufacture of the pipe and any tests being performed by the manufacturer or his suppliers relative to products, materials, or the pipe being produced. Copies of records of tests and inspections shall be submitted if requested by the Engineer.

   a. Pipes: These shall be manufactured and tested in accordance with ASTM D 3262.
   b. Joints: Coupling joints shall meet the requirements of ASTM D 4161 and/or produce a zero leakage joint.
   c. Stiffness: Minimum pipe stiffness when tested in accordance with ASTM D 2412 shall be 46 psi.

9. Fittings and Special Pipe: Fittings shall be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays, all capable of withstanding all operating conditions when installed.

10. Curves of long radius shall be formed by the use of bevel end pipe or by the use of bevel adapters. Deflection of pipe joints to form the long radius curves will not be accepted. Special pipes shall be designed to provide the same strength as the

adjacent pipe. Branch connections or openings, such as manholes and bypass pumping connections, shall be incorporated in straight pipe and shall be suitably reinforced. Special pipes shall be provided with joints corresponding to those on adjoining straight pipes. Special ends shall be provided on pipe, where required, to connect to pipe of other manufacturers and special structures.

11. Unloading Handling and Storage: All pipe shall be inspected at time of delivery, and damaged pieces rejected and removed from the site of the work. Unloading shall be done by mechanical equipment designed to properly handle the pipe, and dropping from delivery vehicles will not be permitted. Pipe shall be stored in an orderly manner to protect the pipe from injury, and from damage by freezing, all in accordance with the manufacturer's written instructions.

I. Ductile Iron

1 Ductile iron pipe for gravity sewer and service connections will conform to ASTM A 746. Ductile iron pipe for force main applications will conform to ANSI A 21.51. The pipe thickness design will conform to ANSI A 21.50. If no thickness class is specified on the Plans or Contract Documents, Class 50 or approved equivalent will be used. All ductile iron pipe will be lined with either Protecto 401 Ceramic Epoxy, SewPer Coat Cement Mortar Lining, or Polyethylene. Linings will be applied according to manufacturer's recommendations. Fittings will conform to the requirements of ANSI A 21.10. Unless otherwise specified, joints will be push-on gasket type conforming to the requirements of ANSI A 21.11. Mechanical joints will conform to the requirements of ANSI A 21.11. Flanged joints will conform to the requirements of ANSI A 21.15. Flexible joint ductile iron pipe for river crossing applications will conform to ASTM A 536 and will be Grade 70-50-05. Steel retainer rings will conform to ASTM A 148 for Grade 90-60.

J. Adapters and Couplings

1. At the direction of the Purchaser, a connection of sanitary sewer pipes, 8 inches through 16 inches, of dissimilar material, different sizes or for the repair of sanitary sewer pipes of similar material may be made by means of an approved compression or mechanical connector or adapter. The gaskets for compression connectors or adapters shall be manufactured of an approved preformed elastomeric material conforming to applicable sections of ASTM Standards C 143, C 425, C 564, and D 3212. Mechanical couplings or adapters shall have tightening clamps or devices made of 300 series stainless steel with a stainless-steel shear ring and stainless-steel hardware, as specified in ASTM A 167. If a stainless steel shear band is not used, a concrete collar shall be required. Each connector and adapter shall bear the manufacturer's name and required markings. Installation shall be by the manufacturer's recommendations.

2. At the direction of the Purchaser, a connection of sanitary sewer pipes (18 inches in diameter and larger) of dissimilar material, different sizes or for the repair of sanitary sewer pipes of similar material may be made in accordance with this Specification. Mechanical connectors meeting the above requirements may be used at the direction of the Purchaser.

K. Crushed Limestone

1. Crushed limestone shall be size No. 67 Coarse Aggregate meeting the requirements of the Tennessee DOT Standard Specifications for Road and Bridge Construction and the following gradation:

	Total Percent by Dry Weight, Passing Each Sieve (U.S. Standard)				
Size No.	1"	3/4"	3/8"	No. 4	No. 8
67	100	90-100	20-55	0-10	0-5

L. Pit Run Gravel

1. Pit run gravel shall consist of one of the three gradations shown in the table below.

	Total Percent by Dry Weight, Passing Each Sieve (U.S. Standard)						
Size No.	2½"	2"	1½"	1"	3/8"	No.40	Clay *
1	100	95-100			35-65	10-30	1-12
2		100	95-100		40-65	10-30	1-12
3			100	90-100	45-65	10-35	2-12

*Clay content shall be determined by the Hydrometer Test - AASHTO T 88. Clay content up to 15 percent may be used with the approval of the Purchaser.

2. The portion passing the No. 40 sieve shall be known as the binder. The binder aggregate shall consist of hard durable particles of limestone or sound siliceous material. Shale

aggregate or pipe clay binder shall not be acceptable. The percent of silt shall not exceed the percent of clay by more than 25 percent. If the binder material is insufficient to bond the aggregate a satisfactory binding material may be incorporated, as approved by the Purchaser, so that the resultant mixture shall comply with these Specifications. The mixing shall be done uniformly, and blending of material on stockpiles or in the pits by bulldozers, clamshells, draglines, or similar equipment shall not be permitted.

M. Non-Shrinking Grout

a. Grout shall be mixed in small quantities as needed and shall not be re-tempered or used after it has begun to set. Unless otherwise specified, the grout shall consist of one part Portland cement, two parts masonry sand by volume, a non-shrinking, nonmetallic admixture and sufficient water to form a grout of proper consistency. When non-shrinking or non-shrinking fast setting grout is specified it shall be formulated by the incorporation of an admixture, or a premixed grout may be used.

N. High Density Polyethylene (HDPE) Pipe and Fittings

a. High Density Polyethylene Pipe (HDPE) may be used in construction of inverted siphons. No HDPE will be allowed in any other gravity sewer application. All HDPE shall be manufactured from virgin, extra high molecular weight, high density PE3408 or PE3608 polyethylene pipe grade resin to a minimum cell classification of PE345434C as determined by ASTM D3350. No post-consumer recycled polyethylene materials shall be allowed. The minimum material classification shall conform to III C 5 P34 as determined by ASTM D1248.

b. All HDPE pipe and fittings shall conform to ASTM F714 and ASTM D3261, respectively, and have a Standard Dimension Ratio (SDR) of 17, maximum.

c. Successive joints of HDPE pipe shall be joined by heat fusion at a fusion pressure of 75 psi and temperature of 400° F. All such connections shall be performed in strict accordance with the manufacturer's instructions.

O. Steel Casing Pipe

1. Casing pipe will conform to ASTM A 139. Minimum yield strength will be 35,000 psi. Wall thickness will meet the requirements of the latest revision of the American Railway Engineering Association Manual of Recommended Practice unless otherwise specified. Wall thickness will be:

Nominal Thickness Inches	Nominal Diameter Inches
0.188	Less than 14
0.219	14 and 16
0.250	18
0.281	20
0.312	22
0.344	24
0.375	26
0.406	28 and 30
0.438	32
0.469	34 and 36
0.500	38, 40, and 42

2. When casing is installed without a protective coating and is not cathodically protected, the wall thickness shown above will be increased to the nearest standard size that is a minimum of 0.063 inches greater than the thickness shown. This requirement does not apply to casing diameters less than 12 3/4 inches.

2.02 EQUIPMENT

A. The Subcontractor shall furnish and maintain in good condition all equipment and facilities as required for the proper execution and inspection of the Work. All equipment and facilities shall be on site and approved by the Purchaser before work will be permitted to begin.

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 EXCAVATION

A. All excavation performed under this Section including trench excavation, structure excavation, and channel excavation, but excluding undercut excavation, shall be considered unclassified excavation despite the nature of the material and objects excavated and shall not be measured or paid for separately except as specifically noted. Pavement removal and replacement shall be accomplished as specified in Specification Section 02950.

B. Trench Excavation

1. All trenches shall be open cut unless otherwise shown on the Drawings. Tunneling, boring, or jacking may be allowed by written permission of the Purchaser.

2. Trenches may be excavated by machinery to a depth that will not disturb the finished subgrade. The remaining material shall be hand excavated so that the pipe is bedded on a firm, undisturbed subgrade.

3. No more than 300 feet of trench shall be opened ahead of the completed sanitary sewer, nor will more than 100 feet be left unfilled except by written permission from the Purchaser. In special cases, the Purchaser may limit the distance to which the trench may be opened by notifying the Subcontractor in writing.

4. The width of trenches below a level 1 foot above the outside top of pipe shall be at least 6 inches but not more than 12 inches on each side of the outside of the pipe for all sizes up to and including 16 inches in diameter. A maximum trench width dimension for these pipe sizes shall be 42 inches. For 18-inch diameter pipes, the width of trenches below a level 1 foot above the outside top of pipes shall be at least 6 inches on each side of the pipe, with a maximum trench width of 42 inches. For pipe sizes more than 18 inches, the width of trenches below a level 1 foot above the outside top of the pipe shall be at least 12 inches but no more than 15 inches on each side of the outside of the pipe. If the trench width at or below 1 foot above the top of pipe exceeds the width specified, provisions shall be made at the Subcontractor's expense to compensate for the additional load upon the pipe.

5. The sides of the trench shall be as nearly vertical as possible. The bottom of the trench shall be carefully graded, formed, and aligned according to SARP10 *Trench Cross Section Showing Terminology* Figure and to the satisfaction of the Purchaser before sanitary sewers are laid.

C. Other Excavation

1. Undercut Excavation: Undercut excavation shall consist of removing and disposing of unsatisfactory material below the grade established on the Drawings for sanitary sewers, structures, and manholes. No undercut excavation shall be done without prior authorization of the Purchaser. The limits of undercut excavation shall be determined by the Purchaser’s Resident Project Representative who will be present during the undercut operations.

2. Undercut areas shall be backfilled with No. 67 limestone or other aggregate approved by the Purchaser to the grade established on the Drawings to produce a suitable foundation. The backfill shall be placed in 6 inch maximum lifts and compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698) or a minimum relative density of 0.75.

3. Unauthorized Excavation Below Subgrade or Outside Limits: Any unauthorized excavation and subsequent removal and backfilling beyond the lines and grades shown on the Drawings shall be at the Subcontractor’s expense. The excess space between the undisturbed bottom and sides of the excavation and subgrade limits shown on the Drawings shall be backfilled according to this Specification.

D. Change in Location and Grade

1. If the Purchaser orders in writing that the location or grade of a proposed sanitary sewer facility be changed from that shown on the Drawings, the following provisions will apply. If the change is made before excavation work has begun and the item being constructed is covered in the Proposal Sheet(s) by pay items with appropriate depth classifications, the appropriate pay item will apply. If the facility being constructed is not covered in the

Proposal Sheet(s) and if the average excavation per linear foot at the changed location or grade is within 10 percent of the original Plan quantity, there will be no change in the unit price for this work. If the average excavation per linear foot at the changed location varies more than 10 percent above or below original Plan quantities, a Contract Revision will be prepared to cover the new work. For purposes of comparing changed quantities with Plan quantities, a 1 foot long strip will be calculated from natural ground line to invert along both the revised and original locations. These calculations will then be multiplied by the proper lengths to determine the total cost.

2. If the change is made after excavation has already begun on the original Plan location, the procedures described above shall apply to payment for work along the changed location. If abandonment of an existing excavation is required due to a change by the Purchaser, a Contract Revision shall be prepared covering the backfilling and restoration of the abandoned excavation. Backfilling and restoration of the abandoned excavation shall be accomplished according to the appropriate section of these Specifications.

3. Filling a portion of existing excavation to meet changed grades shall be accomplished in accordance with this Specification.

4. If a change in a location and/or grade is authorized in writing by the Purchaser at the written request of the Subcontractor, the Subcontractor shall not receive any additional compensation for the changed work. Backfilling and restoration of abandoned excavation work shall be accomplished totally at the Subcontractor's expense. If changes requested by the Subcontractor result in reduced lengths and/or depth of excavation, the revised quantities using Proposal unit prices or Contract Revisions as appropriate shall be used to develop payment.

E. Disposition of Excavated Material

1. Excavated material suitable for backfill shall be stored no closer than 2 feet from the edge of the excavation. Excavated material shall not obstruct crosswalks, sidewalks, driveways, street intersections, nor interfere unreasonably with travel on streets. Gutters or other surface drainage facilities shall not be obstructed. The Subcontractor must provide access to fire hydrants, mailboxes, sewer and conduit manholes, and similar utility or municipal service facility as required. Excavated material intended for backfill shall be stored in a way that minimizes loss of excavated material due to erosion. The Subcontractor shall comply with all applicable OSHA regulations and City of Memphis Storm Water Ordinances.

2. Unless otherwise directed, all excavated material that will not be used for backfilling or restoration shall be removed from the site and disposed of by the Subcontractor. If the Subcontractor proposes to store or place such excess excavated material upon any private property, written consent of the property owner or owners must be obtained by the Subcontractor in advance. A certified copy shall be given to the Purchaser. No surplus or excess material shall be deposited in any stream channel nor anywhere that would change preconstruction surface drainage.

F. Control of Water

1. The Subcontractor shall keep all excavations free of water. If the trench subgrade consists of good soil in good condition at the time of excavation, it shall be the Subcontractor's responsibility to maintain it in suitable condition. Dams, flumes, channels, sumps, or other work and equipment necessary to keep the excavation

clear of water shall be provided by the Subcontractor. Dewatering of trenches shall be incidental to trench excavation. The Subcontractor shall avoid producing mud in the trench bottom by

his operations. If necessary or so ordered by the Purchaser, the Subcontractor shall remove any soil that becomes unacceptable and replace it with limestone or other approved aggregate at his own expense to maintain a firm, dry base.

2. Pipe embedment, laying, jointing, and the placing of concrete or masonry shall be done in a water free trench or excavation. Trenches shall be kept clear of water until pipe joints, concrete and masonry have set and are resistant to water damage. The water shall be disposed of in a manner acceptable to the Purchaser.

3. All gutters, pipes, drains, conduits, culverts, catch basins, storm water inlets, ditches, creeks, and other storm water facilities shall be kept in operation, or their flows shall be satisfactorily diverted and provided for during construction. Any facilities disturbed during construction shall be restored to the satisfaction of the Purchaser.

G. Excavation Around Obstructions

1. The Subcontractor shall cautiously excavate to find the limits of underground obstructions anticipated within the excavation. When a water pipe, gas pipe, other sanitary sewer, storm drain, or similar utility comes within the limits of the trench, such facilities will be properly supported.

2. The Subcontractor shall perform all excavation by hand where excavation machinery would endanger trees, structures, or utilities that otherwise might be saved by hand excavation.

3. Hydroexcavation/Hand Digging

   a. The Subcontractor, in order to protect existing utilities, shall cautiously hydroexcavate or hand excavate the entire perimeter of the excavation to a minimum depth of four feet to locate all underground obstructions within the excavation. The excavation method to be utilized on any given repair (hydroexcavation or hand digging) is at the Subcontractor's discretion. When a water pipe, gas pipe, other sanitary sewer, storm drain, or similar utility comes within the limits of the trench, such facilities shall be properly supported.

H. Excavation for Manholes and Special Structures

1. The Subcontractor shall be responsible for performing the Work according to the lines and elevations shown on the Drawings or as directed by the Purchaser. The Subcontractor shall excavate as required for all structures with foundations carried to firm, undisturbed earth at the elevation of the underside of the structure.

2. The outside dimensions of excavations for manholes and special structure shall be at least 12 inches greater than the outside of the masonry or concrete work to permit backfilling around the structure.

3. Where structures are to be built in street rights-of-way or paved areas, the excavation shall not exceed 2 feet from the outside of the masonry or concrete work. If the excavation exceeds this limit, the Subcontractor shall be required to backfill the entire space around the structure with pit run gravel compacted as specified in this Specification.

I. Special Protection

1. Treacherous Ground: When running sand, quicksand, or other treacherous ground is encountered, the work shall be carried on with the utmost urgency and shall continue day and night should the Purchaser so direct.

2. Sheeting and Shoring: The Subcontractor shall furnish, place, and maintain sheeting and shoring as required to support the sides of any excavation to prevent earth movement that could endanger the workers or public and to prevent damage to the excavation, adjacent utilities or property. The Subcontractor shall place this sheeting and shoring without the Purchaser's instructions.

3. Sheeting shall extend below structure invert a sufficient depth to assure adequate support. In the installation of sheeting, the use of vibratory type pile drivers (as opposed to impact type) shall be limited to sheeting driven no greater than 5 feet below the invert. The sheeted trench width, as measured between those faces of the sheeting in contact with the earth trench wall, shall not exceed the maximum width of a trench. Walers and struts shall be designed and installed to present no obstructions to proper placement of the pipe, pipe embedment, cradle or encasement, and they shall not interfere with the satisfactory installation of the pipe.

4. Sheeting, bracing, and shoring shall be withdrawn and removed as the backfilling is being done, except where the Purchaser permits the material to be left in place. The Subcontractor shall cut off sheeting left in place at least 2 feet below the surface and shall remove the cut off material from the excavation.

5. All sheeting, bracing, and shoring which is not left in place under this provision shall be removed in a way that will not endanger the completed work or other structures, utilities, storm drains, sewers, or property. The Subcontractor shall be careful to prevent the opening of voids during the extraction process.

6. If sheeting and shoring are not specifically required on the Drawings or in the Specifications, steel drag shields or trench boxes may be used subject to the authorization of the Purchaser. Voids left by the advancement of the shield shall be carefully backfilled and compacted following trench backfill requirements.

7. Excess Width of Trench: If the Subcontractor is permitted to use equipment that results in wider trenches than specified, approved methods shall be used around the pipe to resist the additional load caused by the extra width. The dimensions of the cradle or other methods will be specified by the Purchaser. The Subcontractor shall be responsible for meeting all applicable OSHA requirements. No extra compensation will be allowed for the additional material or work. Excess width trenches for semi-rigid and flexible pipe shall be backfilled and compacted according to ASTM D 2321, and no concrete cradle shall be used.

8. Underpinning: When excavations require underpinning of existing structures, the Subcontractor shall submit shop drawings of underpinning details to the Purchaser for review before commencement of excavation below the foundation of the structure. Review of underpinning details by the Purchaser shall not relieve the Subcontractor of his responsibility for protection of the structure and its contents.

J. Existing Utilities

1. It shall be the Subcontractor's responsibility to arrange for the location of existing

utilities prior to excavation. The Subcontractor will also be responsible for coordinating the relocation of any existing utilities with the appropriate utility owner.

2. Protection: The Subcontractor shall protect any storm drain, sewer, or utility within the limits of the construction. The Subcontractor shall proceed with caution and shall use every means to establish the exact location of underground structures and facilities before excavating in the vicinity. The Purchaser shall not be responsible for the cost of protection or repair or replacement of any structure, pipe line, conduit, service connection, or similar facility broken or damaged by the Subcontractor's operations. All water and gas pipes and other conduits near or crossing the excavation shall be properly supported and protected by the Subcontractor.

3. If the construction requires the removal and replacement of any overhead wires or poles, underground pipes, conduits, structures or other facilities, the Subcontractor shall arrange for such work with the Owner or Owners of the facilities. No additional payment will be made by the Purchaser for this work.

4. Service Connections: Sewer and utility services between mains and buildings shall be maintained and adjusted as necessary by the Subcontractor to provide as nearly a continuous operation as can be expected. This shall be accomplished in any way that the Subcontractor chooses, provided the individual service is not interrupted for more than two consecutive hours. The occupants shall be notified by the Subcontractor at least six hours before such service interruptions. When a break occurs, the Subcontractor shall notify the affected occupant(s) of the probable length of time that the service will be interrupted. New service laterals with double-sweep cleanouts will be required to be installed to the property line for each service and reconnected to the existing service if one exists. If no service exists, the Subcontractor shall cap the pipe after installing a cleanout.

5. If existing underground facilities or utilities require removal and replacement for the performance of this work, all replacements shall be made with new material conforming to the requirements of these Specifications. If not specified, the material will be as approved by the Owner.

6. The removal and replacement of water services to adapt to new construction shall be the Subcontractor's responsibility within the limits where the new service line grade blends smoothly with the existing service line grade.

8. The Subcontractor shall be responsible for any damage to the sewer house connection because of his operations. The Purchaser does not guarantee the number, size, condition, nor length of adjustment necessary to bring a service to a new grade.

3.02 SEWER PIPE INSTALLATION

A. General

1. Sewer pipe and pipe embedment shall be constructed as shown on the Drawings. It shall be the Subcontractor's responsibility to find all underground utilities before construction to ensure there are no conflicts with the proposed line and grade. The Subcontractor’s surveyor shall verify the base information on the Drawings prior to commencement of construction. Any discrepancies in the Drawings shall be reported to the Purchaser immediately. If approved by the Purchaser, minor changes in the alignment or grade will be permitted to avoid underground facilities, if straight alignment can be maintained between manholes. If minor changes in line or grade cannot avoid a conflict with the existing utility, the Subcontractor shall arrange with

the owner of said utility to have it adjusted as required to accommodate the proposed sewer at no additional expense to the Purchaser.

B. Modifications of Existing Sanitary Sewer Facilities

1. Maintenance of Flow: Where existing sewer lines are being modified, the Subcontractor shall arrange his work so that sewage flow will be maintained during the construction period with no discharge of sewage into the open trench, and no back up of sewage in the existing line. The Subcontractor shall provide necessary bypass pumping capacity to carry flow downstream of the section to be modified.

2. Abandonment of Sewer Pipe: Sewer pipe called for in the Specifications or Drawings to be abandoned shall be sealed at each end for a minimum distance of 18 inches, or one-half the diameter of the pipe, whichever is greater. Unless otherwise specified, the pipe shall be sealed with a brick bulkhead and/or acceptable cement grout to form a solid watertight plug completely bonded to the pipe.

3. The Subcontractor shall be allowed to remove pipe to be abandoned if wanted. If the Subcontractor elects the removal method, all associated costs shall be included in the cost for other Pay items.

4. Connection to Existing Manholes: The Subcontractor shall cut suitable openings into existing manholes or remove existing pipe to accommodate the sewer pipe at the proper elevation, location, and direction, as indicated on the Drawings. Care shall be used to avoid unnecessary damage to the existing manhole.

5. All loose material shall be removed from the cut surfaces that will be completely coated with non-shrinking grout before setting the pipe. Before inserting the pipe, a sufficient thickness of grout shall be placed at the bottom and sides of the opening for proper bedding of the pipe. For semi-rigid and flexible pipe installations a water stop as approved by the pipe supplier shall be installed on the pipe according to the manufacturer's recommendations. After setting, all spaces around the pipe shall be solidly filled with non-shrinking grout and neatly pointed up on the inside to present a smooth joint, flush with the inner wall surface. Any necessary revisions on the existing manhole invert shall be made to provide a smooth, plastered surface for properly channeled sewage flow from the new connection. Plaster on the exterior of brick manholes shall be repaired with non-shrinking grout. Particular care shall be given to insure that the earth sub-base and bedding next to the manhole will provide firm solid support to the pipe.

6. Removal of Sewer Pipe: Existing pipes and manholes to be removed and their locations shall be shown on the Drawings. Existing sewer pipe and manholes that must be removed to excavate for the proposed sewer shall be included in the cost of the proposed sewer pipe and no additional compensation shall be made to the Subcontractor. The City reserves the right to retain or reject salvage of any material encountered. All remaining material becomes the property of the Subcontractor who shall be responsible for properly disposing of the same.

3.03 PIPE EMBEDMENT

A. Pipe embedment will be defined as that material supporting, surrounding and extending to 6 inches above the top of the pipe. Pipe Embedment for sewer pipe shall conform to the requirements given below. At the direction of the Purchaser or as shown on the Drawings, sewer pipe and backfill shall be encapsulated in geotextile fabric meeting the following requirements:

Physical Property	Test Method	Acceptable Test Result
Tensile Strength, wet, lbs.	ASTM D-1682	200 (min)
Elongation, wet, %	ASTM D-1682	40 (min)
Coefficient of Water Permeability, cm/sec	Constant Head	0.03 (min)
Puncture Strength, lbs.	ASTM D-751	100 (min)
Pore Size - EOS U.S. Standard Sieve	Corps of Engineers CW-02215	40 (max)

B. Crushed Limestone

1. Pipe embedment material shall be Number 67 crushed limestone. Pipe 8 inches to 24 inches in diameter shall be bedded on 4-inches of Number 67 crushed limestone. Pipe 27 inches to 48 inches in diameter shall be bedded on 6-inches of bedding material. Pipe embedment for pipes larger than 48 inches in diameter shall be by design based on anticipated soil conditions. After pipe installation, crushed limestone shall then be tamped under the haunches and continued in layers not more than 6 inches in loose thickness around and above the pipe to a level 6 inches above the outside top of the pipe. The remainder of the installation shall be as outlined in this Specification's Backfill requirements.

3.04 PIPE LAYING

A. Inspection Before Laying

1. All pipe shall be inspected upon delivery. Pipe that does not conform to the requirements of these Specifications or is not suitable for use will be rejected by the Purchaser and immediately removed from the work site.

B. Preparation of Pipe Ends

1. All surfaces of the pipe to be joined shall be clean and dry. All necessary lubricants, primer, adhesives, and similar material shall be used as recommended by the pipe or joint manufacturer's specifications.

C. Care During Hoisting, Placing, And Shoving Home

1. Equipment used to handle, lay, and join pipe shall be equipped and used as to prevent damage to the pipe. All pipe and fittings shall be carefully handled and lowered into the trench. Damaged pipe or jointing material shall not be installed.

D. Direction of Work

1. The laying of pipe shall be commenced at the lowest point. The bell or grooved end shall be laid upgrade. All pipe shall be laid with ends abutting and true to line and grade. The pipe ends shall be carefully centered so that when laid they will form a sewer with a uniform invert.

E. Uniform Pipe Bearing

1. Special care shall be taken to insure that the pipe is solidly and uniformly bedded, cradled, or encased according to the Drawings. For pipe with a bell that is larger than the barrel of the pipe, the bedding material shall be removed to a depth that will provide continuous support for the bell and barrel. No pipe shall be brought into

position for joining until the preceding length has been bedded, joined, and secured in place. Where a concrete cradle is required, the pipe shall be supported at no more than two places with masonry supports of minimum size sufficient to provide the required clearance and to prevent displacement during placing of concrete.

F. Alignment and Grade

1. Each piece of pipe shall be checked for vertical and horizontal alignment immediately after being laid. All adjustments to alignment and grade must be made by scraping away or filling in under the barrel of the pipe and not by wedging or blocking up any portion of the pipe or striking the pipe to drive it down. Curved alignments shall not be allowed except as directed by the Purchaser.

G. Backfilling to Secure Pipe

1. When the joint is made, sufficient backfill material shall be simultaneously placed along each side of the pipe to prevent moving the pipe off line and grade. Particular care shall be used to prevent disturbance or damage to the pipe and the joints during backfilling.

H. Flotation and Water in the Trench

1. The Subcontractor shall take all necessary precautions to prevent flotation of the pipe in the trench. Water shall not be allowed to rise in the trench. The Subcontractor shall use well points, sump pumps, or another approved method of dewatering as required to lower the water table below the bottom of the excavation while minimizing the migration of fines from the surrounding area. The Subcontractor shall make a request to the Purchaser and receive approval prior to the use of special dewatering equipment other than well points or sump pumps. Dewatering operations are considered incidental to the work and no additional compensation will be made to the Subcontractor.

I. Open Ends

1. Whenever pipe laying is stopped for any significant length of time, such as at the end of a workday, the unfinished end shall be protected from damage and a temporary tight fitting plug or bulkhead shall be placed in the exposed ends of the pipe to keep soil or other debris from entering the pipe.

J. Concrete Cradle Section next to Manhole

1. The pipe shall be supported from the manhole wall to the limits of the manhole excavation in a normal sewer trench with a concrete cradle, structurally continuous with the manhole base slab or footing. Cost for this work is incidental to the cost of the pipe installation.

K. Cutting Pipe

1. Cutting shall be in a neat workmanlike manner at right angles to the pipe axis without damage to the pipe. The Subcontractor shall smooth the cut end by power grinding or filing to remove burrs and sharp edges.

L. Wyes and Special Fittings

1. Wyes, stubs, reducers, fittings, or other special pipes shall be installed as shown on the Drawings or where ordered by the Purchaser. The fittings and special pipes shall

be made of a compatible material, type, and class and/or strength designation as the pipe and installed as required by the Drawings and Specifications. The cost for providing and installing the above items is incidental to the cost of the pipes.

3.05 PIPE JOINTS

A. General

1. Pipe shall be jointed immediately following the laying of each section. No pipe section shall be left overnight which has not been completely jointed to the preceding pipe section in conformance with these Specifications.

2. The following provisions will apply to insure tight and sound joints:

   a. The joint will be placed with special care to avoid breaking joints and to leave gasket, if required, in proper position.
   b. All pipe 12 inches in diameter or larger will have dead weight held by crane while being lined up and pushed home.
   c. Pipe will be pushed home with a constant and even force and not jarred home by the momentum of a moving force that will place an impact load on pipe.
   d. Cement and lubricant will be used as recommended by the manufacturer and designated by the Purchaser.

B. Compression Joints

1. The two ends to be joined shall be thoroughly cleaned and a compression gasket compatible with the type of pipe to be joined shall be at the position recommended by the pipe manufacturer.

2. Lubricant recommended by the gasket manufacturer shall be liberally applied to the gasket and both ends immediately before pipe ends are joined. The upstream pipe shall be positioned such that the spigot may enter the bell squarely. The pipe being laid shall be pushed home and the gasket position checked with a feeler gauge before installation of the next section. Flat, unconfined gaskets on concrete pipe shall be cemented to the spigot at the position recommended by the pipe manufacturer.

C. Mechanical Joints

1. The two ends to be joined shall be thoroughly cleaned with a wire brush and the plain end, socket end, and gasket shall be brushed with soapy water. The end shall be centered in the socket and adequate anchorage shall be provided to hold the pipe in position until the joint can be completed. When deflecting pipe from a straight line is necessary, the deflection shall be made after joint assembly and before tightening bolts. Pipe deflection shall not exceed that specified by ANSI C 600.

2. When tightening bolts, it is essential that the gland be brought up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. All bolts shall be torqued to the required range recommended by the pipe manufacturer. The Subcontractor shall avoid over stressing the bolts. Gauge lines on the spigot end shall be checked following assembly to ensure proper positioning of bell and spigot has been accomplished.

3. Any joints not properly positioned shall be disassembled, cleaned, and reassembled as previously indicated.

D. Flanged Joints

1. The two ends to be joined shall be thoroughly cleaned with a wire brush. Bolt holes on each pipe flange to be joined shall be aligned and bolts inserted. Bolts shall be torqued evenly by alternating tightening of bolts opposite one another until all bolts are torqued to the recommended pressure.

F. Restrained Joints

1. Restrained push-on joints are to be used as specified on the Drawings or by the Purchaser. These special joints shall be installed as specified by the manufacturer. The length of the pipe to be restrained will be determined by the Purchaser based on pipe size, internal pressure, depth of cover, and soil characteristics around the pipe.

3.06 SERVICE CONNECTIONS

A. The Subcontractor shall install a new lateral with cleanout for each house connection. Cleanouts should be located on the property line or easement with 6-inch PVC (SDR 26) with a minimum slope of 1 percent unless otherwise directed by the Purchaser.

B. The Subcontractor shall provide a Double Sweep PVC cleanout with a PVC screw plug cap and 4-inch PVC stack pipe. When installed, the cap shall lie 3-inches below finished grade.

C. If the existing service connection is 4-inch diameter, the Subcontractor shall provide a 6-inch to 4-inch concentric PVC reducer to connect the new 6-inch lateral to an existing 4-inch private property lateral.

D. The Subcontractor shall connect the new lateral to the PVC main with a PVC fitting in accordance with the details shown on *Typical Installation of Service Lateral*.

3.07 PIPE CAPS AND PLUGS

A. Wyes, stubs, or other fittings installed in the pipe for future connections shall be closed at the open end. For pipes 21 inches in diameter or smaller, an approved cap or plug shall be installed in the bell or socket using the same type joint or jointing material as required for the sewer. For pipes larger than 21 inches in diameter, temporary approved masonry bulkheads of the thickness required by the Drawings and Specifications to close the open end may be substituted for stoppers. Care in backfilling shall be used so that such closure and its seal will not be disturbed. This stopper shall be jointed so that it may be removed later without injury to the pipe itself. Work and material is incidental to the cost of the pipe installation.

3.08 INVERTED SIPHONS

A. Each siphon will include inlet, outlet, and any intermediate manholes where shown on the Plans with all foundations, pipes, and pipe encasement and other appurtenances. Pipe to be included in the cost of the siphon is to be all pipe, fittings and specials between the center of the inlet manhole and the center of the outlet manhole.

B. The Contractor will construct cofferdams, temporary bulkheads, perform all pumping and other work necessary to protect the siphon during construction. The Contractor will be required to maintain a dry trench during construction, and will never be permitted to lay pipe or place concrete with water in the trench. Trenches will be kept free from water until the material in the joints and masonry has sufficiently hardened.

C. Unless otherwise specified, inverted siphon pipe will be HDPE conforming to Specification Section 02530 Paragraph 2.01.N. The siphon pipes will be encased in concrete at the locations and to the dimensions shown on the Plans or Design Standards. The excavation, bedding, laying, jointing, pipe encasement, and backfill operations will conform to the applicable sections of this Specification.

D. When shown on the Plans, flexible joint ductile iron pipe will be used instead of push-on joint pipe as shown on Design Standards. Flexible joint pipe will be laid such that the maximum joint deflection as specified by the pipe manufacturer for each joint is not exceeded.

E. The inlet, outlet, and any intermediate manholes will be constructed according to the requirements of Specification Section 02531.

F. The inlet and outlet manhole inverts will be carefully shaped to conform to the inlet and outlet pipes and cause the least possible resistance to flow. The inlet manhole will have an invert weir constructed to contain low flows to a single siphon pipe. The invert weir will be level across the top and constructed to the elevation shown on the Plans. The outlet manhole invert will be formed to reduce backflow into the inactive siphon pipes.

3.10 BACKFILLING

A. General

1. After sanitary sewer facilities have been bedded and installed according to these Specifications and upon permission of the Purchaser, the backfill may be placed. Backfilling operations shall continue following as closely behind pipe installation as practical. All backfill shall be placed in uniform horizontal layers. Pushing backfill material down a ramp into excavated areas will not be permitted. No trash will be allowed to accumulate in the space to be backfilled. Particular care shall be taken to avoid allowing wood to be included in the backfill, other than sheeting and shoring that has been approved by the Purchaser to be left in place.

2. The Subcontractor shall be responsible for the condition of the trenches and filled areas during the contract and warranty period. The Subcontractor shall maintain frequent inspection of the same. If at any time during the 12-month warranty period the trenches or filled areas settle and sunken places appear, the Subcontractor shall be required to refill these sunken places when they are discovered with suitable material and will replace all damaged curb, gutter, and sidewalk. All soft or dangerous trenches shall be marked, barricaded and caution lighted for the protection of the public.

3. Property with an existing dwelling located on it or lots within a developed subdivision or planned development are considered improved property.

B. Street Right-of-Way and Improved Property

1. Backfill Material: Backfill for manhole and pipe trench excavations through pavements in street or highway right-of-way or where the Purchaser orders, shall be made with pit run gravel or other acceptable material as approved by the Purchaser. The backfill shall be from the top of the pipe embedment material or manhole foundation to the subgrade elevation of the pavement. Pea gravel or similar granular material approximately uniform in size and without bonding properties will not be used.

2. Backfill for manhole and pipe trench excavations beyond pavements in street or

highway right-of-way or outside public right-of-way shall be made with select earth from the top level of the pipe embedment material or foundation to the subgrade elevation in paved area, or within 1 inch of the surface in areas to be sodded, or to the surface in all other areas.

3. Select material shall be free from debris, organic matter, perishable compressible material and will contain no stones or lumps larger than 6 inches. Rocks and lumps smaller than 6 inches will not exceed an amount that will interfere with the consolidating properties of the fill material. Care shall be taken that stones and lumps are kept separated and well distributed, and that all voids are completely filled with fine material. No rocks or lumps will come in direct contact with the pipe. The upper 3 feet of backfill in sodded or planted areas will be free of rocks or lumps larger than 1 inch in diameter.

4. Placement and Compaction:

   a. Sanitary Sewer Trenches: Backfill material shall be placed by hand in 6 inch loose layers and tamped to a point 2 feet above the outside top of the pipe. Backfill will be compacted with suitable mechanical tamping equipment with special care being taken not to damage the pipe or joints. Use of compaction equipment directly above semi-rigid and flexible pipe should be avoided until sufficient backfill has been placed to ensure that the equipment will not damage the pipe. A minimum of 36 inches of compacted backfill above the top of semi-rigid and flexible pipe shall be in place before wheel loading and a minimum of 48 inches of compacted backfill before use of pneumatic tampers. From these elevations to the subgrade elevation of the pavement, bottom of the sod, or to the original ground surface, suitable backfill shall be mechanically placed in 9 inch, maximum, loose layers. All backfill material shall be compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698).

   b. Manholes and Special Structures: When the masonry or concrete work has set sufficiently to withstand compaction, and the Purchaser authorizes, backfill material will be placed in 6 inch loose layers and compacted with heavy tampers or pneumatic tampers to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698). Suitable backfill shall be placed in this manner from the foundation of the structure to the subgrade elevation of the pavement, the bottom of the sod or to the original ground surface.

C. Open Areas and Unimproved Property

1. Backfill Material: Backfill of excavations on unimproved property shall be made with select material from the top level of pipe embedment material or foundation to the surface. Non-granular select material to be used for backfill will be free from debris, organic matter and perishable compressible material, and will contain no stones or lumps or rock fragments larger than 6 inches. Rocks or lumps smaller than 6 inches in diameter will not exceed an amount that will interfere with the consolidating properties of the fill material. No rocks or lumps shall come in direct contact with the pipe. Stones and lumps shall be kept separated and well distributed, and all voids shall be completely filled with fine material.

2. Placement of Backfill: Backfill procedures specified in Specification Section 02530 Paragraph 3.10.B shall apply from the trench bottom to a point 2 feet above the outside of the pipe. From this point to slightly above the surrounding surface elevation, suitable backfill may be placed by bulldozer or other mechanical means.

E. Removal of Excess Material

1. After the trench or excavation has been properly backfilled, all excess dirt shall be removed from the streets, roadways and improved private property so pavements or turfed areas may be replaced and properties cleaned.

2. In open areas and unimproved property, the excess material may be used to fill low spots on property next to the right-of-way/easement. Before spreading excess soil, the Subcontractor shall obtain written permission from the property owner for the spreading of excess soil, and a copy of the written permission shall be submitted to the Purchaser. Such spreading or filling shall not obstruct surface drainage and be to the satisfaction of the property owner. Excess material shall be disposed of by the Subcontractor.

3.11 BYPASS PUMPING

A. As required for acceptable completion of the work and/or to avoid damages due to sewer spills or overflows, the Subcontractor shall provide for sewer flow maintenance around the line segments and manholes designated for rehabilitation. The bypass shall typically be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent sanitary sewer system. The pump and bypass lines shall be of adequate capacity and size to handle the anticipated flow. Bypassing of sanitary sewage into the storm water system will not be allowed. For all bypass pumping, pump noise shall be kept to a minimum to the satisfaction of the Purchaser. The Subcontractor shall be required to contact all residential and commercial customers whose service lines connect to the sewer main being bypassed and inform them that they will be temporarily out of service. The Subcontractor shall also advise those customers against water usage until the mainline is back in service. After completing the necessary work on the main line, the Subcontractor shall advise those customers that the sewer main is back in service.

B. Bypass pumping is defined as providing pumps, standby pumps, piping, elevated structural support for aerial crossings, manpower to operate, routine maintenance and repair capability, pipe plugs, fuel, route and pump site clearing and any other work necessary to provide a complete bypass pumping operation. Any structures proposed by the Subcontractor for construction over or penetration into the interceptor piping for the purpose of performing the bypass operations must be approved by the Purchaser prior to implementation. The Subcontractor shall submit design drawings and details that are signed and sealed by a professional engineer licensed in the State of Tennessee. All bypass pump schemes must be submitted to and approved by the Purchaser in advance.

C. Public advisory services shall be required to notify all parties whose service laterals will be out of service and to advise against water usage until the mainline is back in service.

D. The Subcontractor shall be required to provide businesses with temporary service, as needed, and shall be responsible for all necessary bypass pumping flows.

3.12 TUNNELING, BORING, AND JACKING

A. General

1. Sewer pipe will be constructed by tunneling, boring, or jacking only at those locations shown on the plans or directed by the Engineer. Carrier pipe for these applications will be of the type specified in the Plans and Specifications. Grade and alignment will be maintained through all liner pipes. The Contractor will submit shop drawings detailing the

method, equipment and material to be used for tunneling, boring and jacking operations to the Engineer for review and approval. The approval by the Engineer of any drawings or plans will not in any way be deemed to release the Contractor from full responsibility for complete and accurate performance of the Work according to the Contract Drawings and Specifications.

2. When tunneling, boring, or jacking is required under railroads, highways, streets, or other facilities, construction will not interfere with the operation of the railroad, street, highway, or other facility and will not weaken or damage any embankment or structure. No water shall be introduced into any tunneling, boring or jacking excavation that lies within City, State or Rail Road right-of-way. A boring that uses a bentonite slurry may be allowed at the discretion of the Engineer and the owner of the right-of-way.

3. The Contractor will be responsible for protection of utilities and sewers against damage by his work. If any utility above or near the tunnel is endangered or has been damaged because of the construction operations, the utility owner will be notified immediately and will be given access to the area to carry out all necessary repairs to such utilities. If any sewers

are damaged, it will be the responsibility of the Contractor to make the necessary repairs. If any public or private property is endangered or has been damaged due to tunneling, boring, or jacking operations, it will be repaired at the Contractor's expense. All cost and expense to the Contractor of carrying out the above requirements will be considered included in his bid prices for the completed sewer installation.

4. Access pits will be of sufficient size to provide ample working space for the jacking or boring equipment, reaction blocks, bracing, liner plates, spoil removal, and 2 sections of pipe. Provisions will be made for the erection of guide rails in the bottom of the pit where applicable. If drainage is to be discharged from the jacking pit, a collection sump will be provided. Wherever end trenches are cut in the sides of the embankment or beyond it, such work will be sheeted securely and braced satisfactorily to prevent earth caving.

5. The Contractor will furnish and operate all necessary pumping equipment of ample capacity and arrange to keep tunnels and shafts free of water during construction and to dispose of water satisfactorily. During placement of concrete, drainage and pumping will be arranged so concrete is placed in dry conditions. No water will flow over the concrete until it has set and will not be damaged.

B. Tunneling

1. The Contractor will carry out the work of tunneling so there will be no cave-in or heaving of earth or other material into the tunnel excavation. If there should be any fall or movement of earth into the tunnel, the Contractor will proceed with the work with all necessary precautions to insure the safety of life and of sewers, utilities and public and private property above and near the tunnel.

2. The Contractor will furnish, place, and maintain all sheeting, bracing, lining or casing required to support the tunnel until the pipe and its bedding, jointing, encasement, and backfilling have been completed. All liners will remain in place.

3. Care will be used in trimming the surfaces of the excavated section and in placing the liners or sheeting and bracing so that the required minimum clearance between the outside of the pipe and the final position of the liners, sheeting and bracing in the tunnel will be attained without any deviation in sewer alignment. Sheeting or lining must be placed and held tightly against the trimmed earth surface of the excavated section so that there will be no voids between the earth and the lining or sheeting.

4. No part of the lining, bracing, or flanges of steel liner plates will project closer to the outside of the pipe or pipe bells than the clearance limits shown on the Plans, or a minimum of two inches, if not shown on the Plans.
5. If timber is used for lining and bracing instead of steel liner plates, invert struts will be placed at the required intervals but in such manner that the pipe and its bedding will be supported entirely by the original earth floor of the tunnel and not on timber lining or bracing. All timbers, when placed for the support of the roof and sides of the tunnel, will be properly fitted and wedged in place. Timber sets in tunnels will be abutting. All voids behind timbers will be filled with blocking or other suitable material.

6. Timbering will be designed and placed to allow the filling of voids. All excavated material not required for backfilling abandoned shafts will be removed from the site and disposed of by the Contractor at his expense.

7. Shafts will be constructed at the location shown on the Plans. Temporary construction shafts will be of adequate size and properly constructed and equipped to meet all safety requirements. All shafts will be barricaded, lighted, fenced, and properly guarded from the beginning of the excavation until the completion of the construction requiring the shaft.

8. Provision will be made at all shafts so that plumb lines suspended on the centerline of the sewer at each end of the shaft will hang freely from the surface.

9. A ladder meeting OSHA requirements will be provided in each shaft and will be kept in safe, good repair, clean and clear of debris.

10. Cavities between the surfaces of excavation and the tunnel liner plates or sheeting will be completely filled with a uniform sand cement grout consisting of 1 part portland cement and 7 parts sand and the minimum amount of water necessary for proper placement. Grout will be placed under pressure through grout holes in the steel liner plates or sheeting. The grout holes will be located and the grout placed in such sequence to insure the complete filling of all cavities and to transfer the load from the undisturbed material to the tunnel lining or sheeting uniformly.

11. After the tunnel section is excavated, lined, and braced, the pipe will be placed on and supported by steel rails or other approved supports. The supporting system will assure line and grade and will allow space below the pipe for concrete grout. Care will be used to avoid damage to the pipe and the liner plates.

12. The space between the pipe and the tunnel will be completely grouted with a mixture of sand and portland cement, mixed in the proportions of 1-part cement to 7 parts sand by volume and a minimum amount of water necessary for proper placement whether placed under pressure or by hand.

13. Temporary shafts will be completely abandoned. Unless otherwise specified in the Plans or Contract Documents all sheeting, bracing, and similar items may be removed unless the Contractor requests and receives authorization from the Engineer to leave it in place. No payment will be made for items left in place at the Contractor's option. If the Plans or the Engineer requires leaving the sheeting, bracing, and similar items in place, measurement will be made as provided in Specification Section 02530.5 and payment will be made as provided in Specification Section 02530.6.

C. Boring

1. When required by the Plans, sewers will be installed in bored holes. The holes will be

bored from the downstream end, unless site conditions dictate otherwise and the Engineer approves.

2. The boring machine to be used will be in good condition and capable of drilling the bore hole within the required limits of accuracy. A smooth liner of sufficient strength will be forced into the bored hole to give a tight fit against the earth sides of the bore hole and still provide a uniform clearance of at least two inches around the pipe flange to permit pressure grouting. The liner pipe will be carefully inspected to insure that the carrier pipe can be properly placed.

3. All carrier pipe shall be mechanical joint or restrained joint pipe. Manholes at the ends of a section of bored pipe will not be constructed until the bored section is completed.

4. The following procedures will be used for carrier pipe 18 inches and larger in diameter. The assembled pipe will be placed in the bored hole with approved, non-metallic, casing spacers attached. Casing spacers will be attached in accordance with the manufacturer's recommendations and with a casing spacer installed within 6 inches of each end of the bore. The assembled pipe will be placed in the bored hole only by such method that will keep the joints in compression. Any method that disjoints the pipe while being placed will not be permitted.

5. The ends of the bore shall be sealed with an approved, flexible end seal. The end seals shall be attached in accordance with the manufacturer's recommendations using stainless steel hardware.

6. When unforeseen obstructions or conditions require abandonment of a partially completed bore hole, and the starting of a new hole, the Contractor will grout the abandoned bore hole solid. The Contractor will receive no compensation for any expenses incurred by any unsuccessful attempt.

D. Jacking

1. The Contractor will furnish for the Engineer's review, a plan showing his proposed method of jacking, including the design for the jacking head, jacking support or back stop, arrangement and position of jacks, pipe guides, and similar items in the assembled position. The review of this plan by the Engineer will not relieve the Contractor from his responsibility to obtain the specified results.

2. Heavy duty jacks suitable for forcing the pipe through the embankment will be provided by the Contractor. In operating jacks even pressure will be applied to all jacks used. A suitable jacking head and bracing between jacks and jacking head will be provided so that pressure will be applied to the pipe uniformly around the circumference of the pipe. A suitable jacking frame or backstop capable of resisting the jacking forces will be provided. The pipe to be jacked will be set on guides, properly braced together to support the section of the pipe and to direct it in the proper line and grade. The whole jacking assembly will be placed to line up with the direction and grade of the pipe. The Contractor may use a cutting edge of steel plate around the head end of the pipe extending a short distance beyond the end of the pipe with the inside angles or lugs to keep the cutting edge from slipping back onto pipe.

3. The pipe will be jacked from the downstream end. Manholes at the ends of a section of jacked pipe will not be constructed until jacked section is completed.

4. Any pipe damaged in jacking operations will be removed and replaced by the Contractor at his own expense. Embankment material will be excavated just ahead of the pipe and material removed through the pipe, and the pipe forced through the embankment

with jacks, into the space thus provided.

5. The excavation for the underside of the pipe, for at least one-third of the circumference of the pipe, will conform to the contour and grade of the pipe. A clearance of not more than 2 inches may be provided for the upper half of the pipe. This clearance is to be tapered off to zero at the point where the excavation conforms to the contour of the pipe.

6. The distance that the excavation will extend beyond the end of the pipe depends on the character of the material, but it will not exceed 2 feet in any case. This distance will be decreased if the character of the material being excavated makes it desirable to keep the advance excavation closer to the end of the pipe.

7. A cushion material will be placed in the joints between each pipe section adequate to distribute the jacking forces around the entire periphery of the pipe uniformly.

8. When jacking of pipe is begun, the operation will be carried on without interruption, as much as practicable, to prevent the pipe from becoming firmly set in the embankment.

9. The pits or trenches excavated to allow jacking operations will be backfilled immediately after the jacking of the pipe has been completed according to Specification Section 02530 Paragraph 3.11.

E. Sewer Pipe in Jacked Liner

1. When required by the Plans or Contract Documents, a sewer pipe will be installed by jacking a pipe as a liner and inserting a carrier pipe of required size, type, and class. When using jacking for liners, the steel liner will be welded steel, 35,000 psi yield strength, and of the diameter and wall thickness required on the Plans and Specifications. The Contractor will provide, at his own expense, thicker walled lines if necessary to withstand the forces of jacking. In any case, the Contractor will retain full responsibility for the adequacy of this jacking operation, equipment and material.

3.13 FINAL GRADING

A. Final grading around sanitary sewer facilities shall conform to the elevation of adjacent undisturbed ground or as shown on the Drawings. Sufficient grading shall be done to provide adequate drainage.

3.14 CLEANING

A. All necessary precautions shall be taken to prevent the entrance of mud, sand, or other obstructing material into the pipelines. As the work progresses, the interior of the sewer shall be cleaned of all dirt, jointing material and extraneous material. On small pipe where cleaning after laying may be difficult, a squeegee shall be kept in the pipeline and pulled forward past each joint immediately after its completion. Before final inspection the Subcontractor shall remove all debris and foreign material.

3.15 TRAFFIC CONTROL

A. All traffic control shall be installed and maintained in accordance Section 01551 – Traffic Control for Work Zones. At a minimum, the Subcontractor must have two trucks with flashing yellow lights on the work site. Traffic cones must also be placed downstream of the construction site to divert cars into the adjacent lane(s) per MUTCD requirements. On roads with a heavy traffic volume, a flagman may also be needed to assist with traffic

control. At the end of each working period, the Subcontractor shall plate all open excavations to maintain traffic flow.

3.16 FALL PROTECTION

A. Subcontractor shall install and maintain all fall protection measures in accordance with the SARP10 Loss Control Manual. The Subcontractor shall construct a controlled access zone around the manhole being adjusted. At a minimum, the fall protection zone shall include traffic cones encircled with pennant tape. The controlled access zone must have one point of access with an entrance log.

3.17 PROTECTION OF DOWNSTREAM FACILITIES

A. The Subcontractor must take all steps necessary to assure that no material is allowed to fall into the line during his installation process. The Subcontractor shall bear all cost of repairs resulting from any damages to downstream facilities resulting from failure to abide by this stipulation.

3.18 WASTEWATER SPILLS

A. Should the Subcontractor spill any wastewater, such that the sewage either immediately or ultimately enters the waters of the State of Tennessee, then the Subcontractor shall be completely responsible for any fines or penalties imposed on the Purchaser or the Subcontractor by the USEPA or the State of Tennessee.

PART 4- FINAL TESTING AND ACCEPTANCE

4.01 VISUAL INSPECTION

A. All work will be subject to visual inspection for faults or defects and any such deviation or omission will be corrected at once.

B. A PACP CCTV inspection in accordance with Section 00003 shall be submitted after pipe replacement is competed.

4.02 LEAKAGE TESTS

A. On sewers with no house connections, leakage tests shall be performed on the full length of all sewer lines and manholes in the presence of the Purchaser before acceptance. On all other sewers, an infiltration test shall be performed. The cost of all testing will be included in the unit price for the item being tested.

B. Air Leakage Test for 8-24 inch Diameter Pipe

1. Upon completion of construction, or earlier if the Purchaser deems advisable, the Subcontractor shall provide the necessary equipment and labor to perform low pressure air tests according to ASTM F1417. This test shall be performed in the presence of the Purchaser and shall be for all types of gravity sewer pipe. This test shall also include service lines from manholes.

2. The pressure test gauge will meet the following minimum specifications:

a.	Size (diameter)	4 ½ inches
b.	Pressure Range	0-15 PSI
c.	Figure Intervals	1 PSI Increments

d.	Minor Subdivisions	0.05 PSI
e.	Pressure Tube	Bourdon Tube or diaphragm
f.	Accuracy	Plus or minus 0.25% of Maximum scale reading
g.	Dial	White coated aluminum with black lettering, 270° arc and mirror edges
h.	Pipe Connection	Low male ½ inch NPT

3. Calibration data shall be supplied with all pressure test gauges. Certification of pressure test gauges shall be required from the gauge manufacturer. This certification and calibration data shall be available to the Purchaser whenever air tests are done.

4. Air leakage tests shall be performed on each reach of sewer pipe between manholes after completion of the installation of pipe and appurtenances and the backfill of sewer trenches. The test time shall be determined from the following table. If air tests fail to meet the following requirements, the Subcontractor shall repeat tests as necessary after all leaks and defects have been repaired. Before acceptance, the same sewer reach shall pass the low pressure air test.

Time Required for a 1.0 psig Pressure Drop for Size and Length of Pipe Indicated[1]

Pipe Diameter (in.)	Minimum Time (min:sec)	Test Time for Length of Sewer Tested (min)
8	7:34	1.52 X L(ft)/60
10	9:26	2.374 X L(ft)/60
12	11:20	3.418 X L(ft)/60
15	14:10	5.342 X L(ft)/60
18	17:00	7.692 X L(ft)/60
21	19:50	10.47 X L(ft)/60
24	22:40	13.674 X L(ft)/60

1. Establish the test time for the sewer length from the formula or the minimum time, whichever is greater.

C. Infiltration Test

1. Infiltration tests may be required for the complete line or any portion of it. Failure of any part of the line to pass an infiltration test shall be sufficient reason to require additional work by the Subcontractor to reduce the infiltration in such portions of the line tested. The passing of an infiltration test shall in no way relieve the Subcontractor of any responsibility to repair visible leaks found during the visual inspection.

2. Maximum allowable infiltration shall be 0 gallons per mile per inch of diameter of sewer per 24-hour day at a time. The joints shall be tight, and visible leakage in the joints of leakage greater than that specified above shall be repaired at the Subcontractor's expense by any means necessary.

4.03 DEFLECTION TEST - SEMIRIGID AND FLEXIBLE PIPE

A. All polyvinyl chloride (PVC) pipe and glass fiber reinforced polymer mortar pipe shall be tested for deflection. All testing shall take place after backfill has been in place at least 30 days. All lines shall be thoroughly cleaned before testing to assure accuracy.

B. Tests shall be run using a rigid ball or nine arm mandrel having a diameter of 95% of the inside diameter of the pipe for PVC and 96% of the inside diameter of the pipe for glass fiber reinforced polymer mortar pipe. The mandrel will be pulled freely by hand through the pipe from manhole to manhole. No pipe deflection will exceed 5% for PVC and 4% for glass fiber reinforced polymer mortar pipe. Any section failing the test shall be repaired by re-bedding or pipe replacement and retested to the satisfaction of the Purchaser.

C. The cost of this service shall be included in the unit price bid for the pipe.

4.04 FINAL ACCEPTANCE

A. When all work required by the Contract has been completed, the Subcontractor shall submit to the Purchaser written certification from a registered land surveyor that the centerline of each structure is within 2.0 feet of the centerline of the sewer easement or the location designated on the Drawings. After receiving the surveyor's certification from the Subcontractor, the Purchaser will make a final inspection of the Work, including any tests for operation. After completion of this inspection, the Purchaser will, if all things are satisfactory to him, issue to the Subcontractor a Certificate of Completion certifying that the Work required by the Contract has been completed according to the Contract Drawings and Specifications. However, the Certificate will not operate to release the Subcontractor or his sureties from any guarantees under the Contract or the Performance Bond. Upon receipt of the Certificate of Completion the Subcontractor will clean the premises and see that they are in an orderly condition.

PART 5- MEASUREMENT

5.01 LOCATE AND EXPOSE MAINLINE TERMINUS

A. Locate and expose mainline terminus shall be measured per each.

5.02 UNDERCUT BACKFILL

A. Undercut backfill will be measured by the ton of limestone in place.

5.03 SEWER PIPE

A. Sewer pipe length will be measured per linear foot along the centerline of the pipe from center of manhole to center of manhole. When there are special structures, sewer pipe will be measured from inside face to inside face for the various sizes, types, classes or wall thicknesses.

B. Sewer pipe length measurement will include the length of wyes as measured along the primary axis for all sizes of sewer pipe.

5.04 SERVICE CONNECTION REMOVAL AND REPLACEMENT

A. Service connection removal and replacement for construction of sewer facilities will be measured per each. Service Connections damaged by the Subcontractor that do not require removal and replacement for construction of sewer facilities will not be measured for payment.

5.05 PAVEMENT BACKFILL

A. Pit run gravel or other acceptable material used for backfill under pavements or other areas directed by the Purchaser will be measured by the cubic yard in the following manner. Cubic yards of Pavement Backfill equals the linear feet of sewer pipe installed directly below pavement as measured along the centerline of the pipe multiplied by the trench payline width in feet multiplied by the depth of pavement backfill material in feet divided by 27. The trench payline width is defined as the outside diameter of the sewer pipe plus 2 feet. The depth of pavement backfill is defined as the distance from 6 inches above the top of the sewer pipe to the subgrade elevation of the pavement.

5.06 BYPASS PUMPING

A. Bypass pumping will be measured as a lump sum item.

5.07 TRAFFIC CONTROL

A. Traffic control will be measured as specified in Section 01551 – Traffic Control for Construction Work Zones.

5.08 INVERTED SIPHONS

A. Inverted siphons constructed according to Plans and Specifications will be measured per lump sum for each siphon complete in place.

5.09 HYDROEXCAVATION/HAND DIGGING

A. Hydroexcavation and/or hand digging of the trench perimeter will be measured per linear foot of sewer pipe replaced.

5.10 EXCAVATION

A. All work for excavation, blasting, drainage of trenches and dewatering, backfilling of excavation, compaction, grading, protection of existing utilities, disposal of excess material, and all other similar items included in this section of the Specifications but not covered by a Pay Item herein will be considered obligations of the Subcontractor under other Pay Items of the Contract.

5.09 PIPE WYES

A. Pipe wyes on sewer lines will not be measured for payment, but are incidental to the cost of furnishing and installing sewer pipe.

5.10 STEEL CASING

A. Measurement shall be along the centerline of the installed steel casing pipe. Measurement shall not be made of incidental work, including sheeting, shoring, grout, excavation, backfill, dewatering, or other work related to installing the steel casing pipe complete and in place.

PART 6 - PAYMENT

6.01 LOCATE AND EXPOSE MAINLINE TERMINUS

A. Locate and expose mainline terminus will be paid for at the contract unit price per each. This item will include but not be limited to all means necessary for locating and excavating the terminus of the sewer when no manhole exists. This item will not include any pay items related to the installation of a new manhole.

6.02 UNDERCUT BACKFILL

A. Accepted quantities of undercut backfill will be paid for at the contract unit price per ton of limestone furnished and placed, which will be full compensation for undercut excavation, special protection, protection of existing utilities, and backfilling to bottom of facility subgrade elevations, complete in place.

6.03 SEWER PIPE

B. The accepted quantities of all sewer pipe will be paid for at the contract unit price per linear foot furnished and laid for the various sizes, types, classes, or wall thicknesses of pipe, which will be full compensation for material and material testing, excavation, special protection, protection of existing utilities, maintenance of sewage flow, proper pipe embedment, laying, jointing, cleaning and inspection, conducting acceptance tests, installation of pipe wyes, connection to manholes, adapters and couplings, stoppers, and removal and/or abandonment of existing pipe within the limits of excavation and backfilling outside pavement areas.

6.04 SERVICE CONNECTION REMOVAL AND REPLACEMENT

A. Accepted quantities of building connections removed and replaced will be paid for at the contract unit price per each for various types of building connections, which will be full compensation of excavation, removal of old service line and appurtenances, furnishing and construction of new service lines, connection fitting to main sewer, PVC 4-inch stack pipe, double sweep cleanout, PVC cap with screw plug, 6-inch by 4-inch PVC reducer, and connection to the existing private lateral and appurtenances to remain, backfilling, testing and inspection, complete in place.

6.05 PAVEMENT BACKFILL

A. Accepted quantities of pit run gravel or other acceptable material used for backfill under pavements or other areas designated by the Purchaser will be paid for at the contract unit price per cubic yard furnished and placed, which will be full compensation for furnishing, placing and compacting the selected material.

6.06 BYPASS PUMPING

A. Bypass pumping will be paid at the appropriate contract lump sum price. This item includes all materials and labor necessary to properly comply with the bypass pumping requirements listed in the specification.

6.07 TRAFFIC CONTROL

A. Traffic Control will be paid as specified in Section 01551 – Traffic Control for Construction Work Zones. Traffic control does not apply to segments being replaced in alleys or other locations where traffic is not impacted.

6.08 INVERTED SIPHONS

A. Payment will be made for Inverted Siphons at the contract lump sum price, which price

will be full compensation for material and material testing, excavation, special protection, cofferdams, temporary bulkheads, maintenance of sewage flow during construction, protection of existing utilities, inlet manhole and outlet manhole with rims and covers, intermediate manholes siphon pipe and fittings, concrete encasement, conducting acceptance tests, removal and/or abandonment of existing pipe within the limits of excavation, and backfilling.

6.09 HYDROEXCAVATION/HAND DIGGING

A. Hydroexcavation and/or hand digging of the trench perimeter will be paid per linear foot of pipe installed where one of these methods is used. Payment shall include all material and labor required to complete the item as specified.

6.10 STEEL CASING

A. The accepted quantities of all still casing pipe will paid for at the contract unit price per linear foot furnished and laid for the various sizes, types, classes, or wall thicknesses of pipe, which will be full compensation for installation, labor, pipe, materials, equipment, tools and incidentals necessary to complete the work.

PAYMENT WILL BE MADE UNDER:

Item No.	**Pay Item**	**Pay Unit**
02530-6.01	LOCATE AND EXPOSE MAINLINE TERMINUS	Each
02530-6.02	UNDERCUT BACKFILL	Ton
02530-6.03	**SEWER PIPE**	Linear Foot
02530-6.03.06.10	10” DUCTILE IRON PIPE, CLASS 50	Linear Foot
02530-6.03.15.08.01	8” POLYVINYL CHLORIDE (PVC) 0’ - 6’ DEEP	Linear Foot
02530-6.03.15.08.02	8” POLYVINYL CHLORIDE (PVC) 6.1’ - 10’ DEEP	Linear Foot
02530-6.03.15.08.03	8” POLYVINYL CHLORIDE (PVC) 10.1’ - 14’ DEEP	Linear Foot
02530-6.03.15.08.04	8” POLYVINYL CHLORIDE (PVC) 14.1’ - 18’ DEEP	Linear Foot
02530-6.03.15.15.02	15” POLYVINYL CHLORIDE (PVC) 6.1’ – 12’ DEEP	Linear Foot
02530-6.03.15.24.01	24” POLYVINYL CHLORIDE (PVC) 0’ - 6’ DEEP	Linear Foot
02530-6.03.15.24.02	24” POLYVINYL CHLORIDE (PVC) 6.1’ - 12’ DEEP	Linear Foot
02530-6.03.15.30.01	30” POLYVINYL CHLORIDE (PVC) 6.1’ - 12’ DEEP	Linear Foot
02530-6.04	SERVICE CONNECTION REMOVAL AND REPLACEMENT	Each
02530-6.05	PAVEMENT BACKFILL	Cubic Yard
02530-6.06	BYPASS PUMPING	Lump Sum
02530-6.08	INVERTED SIPHONS	Lump Sum
02530-6.09	HYDROEXCAVATION/HAND DIGGING	Linear Foot
02530-6.10	STEEL CASING	Linear Foot

END OF SECTION 02530

SECTION 02531
INSTALLATION AND REPLACEMENT OF MANHOLES AND CONCRETE WETWELLS

PART 1 GENERAL

1.01 SCOPE

A. This Work shall consist of the removal and replacement of existing or installation of new manholes and concrete wetwells for sanitary sewers as shown on the Drawings, stipulated in the Contract Documents, or as directed by the Purchaser. The construction shall be accomplished by these Specifications and in conformity with the details shown on the Drawings or established by the Purchaser. All requirements for manhole installation and replacement shall apply to concrete wetwells for lift station installations also.

B. Where existing manholes are being replaced, the Subcontractor shall arrange the work such that sewage flow shall be maintained during the construction period with no discharge of sewage slowing into an open trench and provide necessary bypass pumping capacity to carry flow downstream of the manhole to be replaced. Additionally, the Subcontractor shall be responsible for properly removing and disposing of the existing manhole when replaced.

C. All new manholes shall be precast concrete. The top section of the manholes shall be either flat top or eccentric cones as shown on Drawings.

D. Cast iron frames shall be set at the required elevation and properly bonded to the flat top, eccentric cone, or grade rings with two rings of butyl mastic sealant and anchor bolts.

1.02 SUBMITTALS

A. Unless otherwise specified all sample submittals shall be delivered to the Program Manager within two weeks of the NTP.

B. Shop Drawings:

1. Precast Manholes: Details of construction.

2. Precast Base, Cones, and Top Slab Sections: Details of construction.

3. Manholes Over Existing Piping:

    a. Drawings and schedule for diverting flow.

    b. Certificate from manufacturer of castings indicating they meet applicable requirements of these Specifications.

    c. Precast Manhole Sections: Manufacturer’s results of tests performed on representative sections to be furnished.

    d. Certified load test data for precast manhole steps.

    e. Plan for diversion of flow during installation of manhole over existing piping

1.03 DELIVERABLES

A. Manhole Acceptance

1. All manholes shall be subject to visual inspection by the Purchaser’s Representative for

faults, defects, or deviations from the Drawings and any such deviation or omission will be corrected by the Subcontractor. All tests shall be made by the Subcontractor who will provide necessary equipment for testing in the presence of and under the supervision and instructions of the Purchaser's Representative.

B. Manhole Vacuum testing for Precast Manholes

1. The Subcontractor shall provide all labor and equipment for vacuum testing.

2. All manholes shall be vacuum tested following backfill and compaction. The ring and lid casting assembly shall be installed prior to testing. The testing equipment shall consist of a gasoline-powered vacuum pump with sufficient vacuum hose length and a test head of proper size to fit the inside opening of the manhole. The test head shall be equipped with an inflatable rubber bladder to affect the seal to the manhole, an air pressure gauge, and a safety valve for filling the bladder, a 30-inch Hg liquid-filled vacuum gauge, a double air exhaust manifold with quarter turn ball valves, three bolt-on feet, and a bridge assembly with height adjustment rod.

3. Subcontractor shall plug all pipe openings, taking care to securely brace the plugs and the pipe. The plugs shall be placed a minimum of 6 feet beyond the manhole wall.

4. With the vacuum tester in place, Subcontractor shall inflate the compression to affect a seal between the vacuum base and the structure. Subcontractor shall connect the vacuum pump to the outlet port with the valve open and evacuate the manhole to 10-inches Hg (0.3 bar) for 48-inch diameter manholes and 5-inches Hg (0.15 bar) for 60-inch and greater diameter manholes.

5. Subcontractor shall close vacuum inlet/outlet ball valve, disconnect the vacuum pump, and monitor the vacuum for the specified time period. If the vacuum does not drop in excess of 1-inch Hg over the specified time period, the manhole is considered acceptable and passes the test. If the manhole fails the test, the Subcontractor shall identify the leaking areas by removing the head assembly, coating the interior surfaces of the manhole with a soap and water solution, and repeating the vacuum test for approximately thirty seconds. Once the leaks have been identified, Subcontractor shall complete all necessary repairs by sealing the leaks of the manhole to the satisfaction of the Purchaser, and repeat test procedures until satisfactory results are obtained.

Vacuum Test Timetable

Depth (Feet)	**Manhole Diameter (Inches)**		
	48"	**60"**	**72"**
4'	10 sec.	13 sec.	16 sec.
8'	20 sec.	26 sec.	32 sec.
12'	30 sec.	39 sec.	48 sec.
16'	40 sec.	52 sec.	64 sec.
20'	50 sec.	65 sec.	80 sec.
24'	60 sec.	78 sec.	96 sec.
*	5.0 sec.	6.5 sec.	8.0 sec.

*Add extra testing time "T", for each additional 2-foot depth. (The values listed above have been extrapolated for ASTM designation C924-85.

C. Warranty and Guarantee for Precast Manholes

1. The Subcontractor shall guarantee the rehabilitated manholes for ten (10) years after acceptance by the Owner to the extent that he will repair any leaks that may appear in them during this period because of faulty workmanship or materials furnished by him at no additional expense to the Owner.

D. Deliverables

1. The Subcontractor shall provide post-rehabilitation MACP inspections for each manhole in accordance with **Specification Section 00001 – Manhole GPS and MACP Inspection.**

PART 2 PRODUCTS

2.01 MATERIALS

A. Construction Material

1. All material furnished by the Subcontractor shall be new, high quality and free from defects. Previously used material in acceptable condition shall be allowed for bracing, forms, false work, and similar uses. Material not conforming to the requirements of the Specifications shall be considered defective and will be removed immediately from the site.

B. Qualification of Manufacturer

1. Manhole for sanitary sewers shall be the standard product of an established, reputable manufacturer made in a permanent plant. Suppliers for each material to be used by the Contractor shall be subject to the approval of the Purchaser. No material shall be delivered until the manufacturer and product have been approved by the Purchaser.

C. Mortar

1. Mortar shall be composed of one part Portland cement and two parts sand (volumetric measure) thoroughly mixed in a tight box, with water added gradually and mixed continually until mortar has attained the proper consistency for use in brick masonry; prepared only in such quantities as needed for immediate use; mortar mixed for more than 30 minutes, retempered, or previously set will not be allowed.

D. Cast Iron Castings

1. Castings shall be cast iron conforming to the Standard Drawings and the requirements of Class 30 ASTM A48; made accurately to the required dimensions; sound, smooth, clean, and free from blisters and other defects; not plugged or otherwise treated to remedy defects; machined so that covers rest securely in the frames with no rocking, and such that they are in contact with frame flanges for the entire perimeter of the contact surfaces. Castings shall be obtained from Universal Scaffolding.

E. Manhole Steps

1. Manhole steps shall not be allowed in sewer structures.

F. Butyl Mastic Sealant

1. The sealant shall be used when joining the casting frame to the precast manhole to

provide a watertight structure. The sealing compound shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler, and shall contain no solvents, irritating fumes, or obnoxious odors. The compound shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. It shall be supplied in extruded rope form of suitable cross section and in such sizes as to seal the joint space. The Subcontractor shall use two complete ropes at each joint. The sealing compound shall be protected by a suitable removable two-piece wrapper, which shall be designed so that half may be removed longitudinally without disturbing the other half in order to facilitate application of the sealing compound. The sealant shall also meet the requirements of the following table:

Composition	**Test Method**	**Minimum**	**Maximum**
Bitumen (Petroleum Plastic Content)	ASTM D4	50	70
Ash Inert Mineral Matter	AASHTO T11	30	50
Volatile Matter	ASTM D6	---	2.0
Property	**Test Method**	**Minimum**	**Maximum**
Specific Gravity at 77 degrees F	ASTM D71	1.2	1.3
Ductility at 77 degrees F(cm)	ASTM D113	5.0	---
Softening Point	ASTM D36	320 degrees F	---
Penetration 77 degrees F (150 gms) 5 sec.	ASTM D217	50	120

G. Precast Manholes

1. All components shall meet the requirements of the Standard Drawings, ASTM C478, and ASTM C76 Class III. The mix design shall be:

Type I Portland Cement Content	615 Pounds per Cubic Yard
Fly Ash Content	85 Pounds per Cubic Yard
Coarse Aggregate Content	1,600 Pounds per Cubic Yard
Fine Aggregate Content	1,250 Pounds per Cubic Yard
Maximum Water/Cement Ration	0.40
Superplasticizer shall be added to create a workable slump.	

2. All cone sections and transition sections shall be eccentric. Barrel sections shall be custom made with openings to meet indicated pipe alignment and invert elevations.

3. The circumferential reinforcement for the manhole sections shall consist of welded wire fabric per ASTM C478.

4. Manholes shall be constructed with the minimum number of sections possible that the precaster can provide, to minimize the number of joints in the manhole. Minimum manhole section shall be 16 inches deep.

5. Each joint shall be a tongue and groove with two layers of butyl mastic sealant.

6. Pipe Connections:

   a. Pipe connections to precast concrete manholes shall be with A-LOK cast in-place gaskets for new and replacement manholes. Grout shall not be allowed to encase A-LOK gaskets. Pipe connections for cured in place or for existing pipe shall be KOR N SEAL flexible connectors. Proper torque shall be applied to KOR-N-SEAL flexible connectors with a torque wrench per manufacturer's specifications.

7. Channels and benches shall be factory grouted only. There shall be no field grouting of channels or benches.

8. Where possible a minimum line drop of 0.1 foot shall be provided across new manholes.

9. Where the difference in invert elevation of two intersecting sewers in a manhole is 2 feet or more, a drop connection shall be installed as directed by the Purchaser.

10. Where invert elevations are not shown on the Drawings, pipes of differing sizes enter and exit manholes, all pipe crowns shall be matched to the same elevation.

11. The bottom of all precast base sections 4 feet in diameter shall extend a minimum of 6-inches beyond the outside wall of the manhole riser. The bottom of all precast base sections and cast-in-place bases 5 feet in diameter shall extend a minimum of 7-inches beyond the outside wall of the manhole riser. The bottom of all precast base sections and cast-in-place bases 6 feet and larger in diameter shall extend a minimum of 8-inches beyond the outside wall of the manhole riser.

12. For manholes four to six feet in diameter and less than twenty feet deep, precast reinforced concrete manhole base sections shall be a minimum of 8 inches thick. For all others, base sections shall be a minimum of 12 inches thick. All precast manhole base sections shall be reinforced with Number 4 steel reinforcing bars placed 6 inches on center each way and at mid depth of the slab, unless shown otherwise on the Drawings.

13. The interior of the manhole sections shall be a smooth, cylindrical surface. Lifting holes, when provided, shall be filled with expanding grout, or other approved materials.

14. All precast reinforced concrete manhole sections specified herein shall be inspected by the Purchaser's Representative. All materials that fail to conform to these Specifications will be rejected. After delivery to the Site, any materials that have been damaged in transit or are otherwise unsuitable for use in the Work shall be rejected and removed from the Site by the Subcontractor at no cost to the Purchaser.

2.02 EQUIPMENT

A. The Subcontractor shall furnish in good condition all equipment and facilities as required for the proper execution and inspection of the work. All equipment and facilities will be on site and approved by the Purchaser before work will be permitted to begin.

PART 3 EXECUTION

3.01 SITE PREPARATION AND RESTORATION

A. Rights-of-Way and Easements

1. The Subcontractor shall confine his construction activities to City of Memphis Rights-of-Way and Easements. The Subcontractor shall be responsible for obtaining written

agreements for use of private property outside City acquired rights-of-way/easements for such purposes as storage of material and equipment and access to the construction site. The Subcontractor shall immediately provide a copy of all such written agreements to the City and Purchaser upon obtaining the same.

B. Clearing of Rights-of-Way and Easements

1. The Subcontractor shall confine his clearing of rights-of-way and easements to the least area necessary for construction of facilities shown on the Drawings. The Subcontractor shall protect as many trees and shrubs within the area as possible. Where necessary for construction, the Subcontractor shall clear all live and dead vegetation and growth, pole stubs, logs, and other objectionable material. Cleared material shall be removed to within 3 inches of existing ground. This work shall be done well before excavation operations but only after erosion controls have been placed.

C. Location of Existing Obstructions

1. Locations of obstructions shown on the Drawings are approximate and are not intended as an accurate location of such obstructions. Obstructions not shown on the Drawings but encountered by the Subcontractor shall be removed and replaced in their original state or protected by the Subcontractor at no additional cost to the Purchaser.

D. Removal of Obstructions

1. The Subcontractor shall demolish and remove all structures and structure foundations, abandoned vehicles, appliances, and rubbish within the right of way/easement limits necessary for the performance of the work.

E. Protection of Obstructions Outside Easement Limits

1. The Subcontractor shall protect and avoid damage to all trees, shrubs, plants, fences, structures, and all other objects outside the right of way/easement limits shown on the Drawings and/or Plats due to construction operations. All damage shall be repaired or restored at the Subcontractor's expense. Particular attention shall be paid to avoid damage to trees, shrubs, bushes, and private property located next to rights of way/easements. No trees, plants, or other objects may be removed outside such limits without written permission of the property owner.

F. Special Protection of Obstructions Inside Easement Limits

1. Wherever the underground installation of sanitary sewer facilities will go through surface improvements previously made by the City, other governmental bodies, or property owners, the Subcontractor will be responsible for their protection and preservation. This responsibility includes the removal and storage of such improvements to allow replacement and restoration as close as possible to the undisturbed condition.

G. Disposal of Debris

1. All trees, brush, logs, snags, leaves, sawdust, bark, and refuse shall be collected and disposed of according to the City Code of Ordinances at the expense of the Subcontractor. There will be no separate pay item for disposal of debris. Debris shall be removed from the site when practical and shall not be left until the completion of the contract. Burning of debris shall not be allowed. When material is to be disposed of outside the easement, the Subcontractor shall first obtain written permission from the property owner on whose property the disposal is to be made and will file a copy with the Purchaser. Unless otherwise provided in the Contract Documents, the Subcontractor will

arrange for disposing of such material outside the right of way/easement. No debris will be deposited in wetlands.

H. Replacement of Fences

1. Any fences disturbed inside the right of way/easement limits will be replaced or restored to their original or better condition. Any fences removed will be replaced in their original location. Fences in such poor condition that they cannot be taken down and rebuilt with the same material shall be replaced with new fence material similar in original quality, size, construction, and appearance to the removed fence. Exceptions to this requirement shall be allowed if written releases are obtained from the property owners by the Subcontractor and submitted to the Purchaser.

I. Restoration of Turfed Areas

1. All areas shall be restored as nearly as practicable to their original condition. Finished lawn areas where soil has been deposited shall be cleared to the level of the existing sod and then raked and watered. Areas where sod has been damaged, destroyed, or ruts have been filled shall be resodded. After final restoration of the settled trench surfaces, trench areas and areas regraded as part of the construction shall be resodded, unless otherwise shown on the Drawings or directed by the Purchaser. Sod must be living at the time of final acceptance of the project.

3.02 BACKFILLING

A. General

1. After sanitary sewer facilities have been bedded and installed according to these Specifications and upon permission of the Purchaser, the backfill may be placed. Backfilling operations shall continue following as closely behind manhole installation as practical. All backfill shall be placed in uniform horizontal layers. Pushing backfill material down a ramp into excavated areas shall not be permitted. No trash shall be allowed to accumulate in the space to be backfilled. Particular care shall be taken to avoid allowing wood to be included in the backfill, other than sheeting and shoring that has been approved to be left in place.

2. The Subcontractor shall be responsible for the condition of the trenches and filled areas during the contract and warranty period. The Subcontractor shall maintain frequent inspection of the same. If anytime during the 12-month warranty period the trenches or filled areas settle or sunken places appear, the Subcontractor shall be required to refill these sunken places when they are discovered with suitable material and shall replace all damaged curb, gutter, and sidewalk. All soft or dangerous trenches shall be marked, barricaded and caution lighted for the protection of the public.

3. Property with an existing dwelling located on it or lots within a developed subdivision or planned development are considered improved property.

B. Street Right of Way and Improved Property

1. Backfill Material:

a. Backfill for manhole excavations through pavements in street or highway right of way or where the Purchaser orders, shall be made with pit run gravel or other acceptable material as approved by the Purchaser. The backfill shall be from the top of the pipe embedment material or manhole foundation to the subgrade elevation of the pavement. Pea gravel or similar granular material approximately uniform in size and

without bonding properties shall not be used.

2. Backfill for manhole excavations beyond pavements in street or highway right of way or outside public right of way shall be made with select earth from the top level of the pipe embedment material or foundation to the subgrade elevation in paved area, or within 1 inch of the surface in areas to be sodded, or to the surface in all other areas.

3. Select material shall be free from debris, organic matter, perishable compressible material and shall contain no stones or lumps larger than 6 inches. Rocks and lumps smaller than 6 inches shall not exceed an amount that will interfere with the consolidating properties of the fill material. Care shall be taken that stones and lumps are kept separated and well distributed, and that all voids are completely filled with fine material. No rocks or lumps shall come in direct contact with the pipe. The upper 3 feet of backfill in sodded or planted areas shall be free of rocks or lumps larger than 1 inch in diameter.

4. Placement and Compaction:

   a. Backfill material shall be placed by hand in 6-inch loose layers and tamped to a point 2 feet above the outside top of the pipe. Backfill shall be compacted with suitable mechanical tamping equipment with special care being taken not to damage the pipe or joints. Use of compaction equipment directly above semi-rigid and flexible pipe should be avoided until sufficient backfill has been placed to ensure that the equipment will not damage the pipe. A minimum of 36 inches of compacted backfill above the top of semi-rigid and flexible pipe shall be in place before wheel loading and a minimum of 48 inches of compacted backfill before use of pneumatic tampers. From these elevations to the subgrade elevation of the pavement, bottom of the sod, or to the original ground surface, suitable backfill shall be mechanically placed in 9-inch, maximum, loose layers. All backfill material shall be compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698).

C. Open Areas and Unimproved Property

1. Backfill of excavations on unimproved property shall be made with select material from the top level of pipe embedment material or foundation to the surface. Non-granular select material to be used for backfill shall be free from debris, organic matter and perishable compressible material, and shall contain no stones or lumps or rock fragments larger than 6 inches. Rocks or lumps smaller than 6 inches in diameter shall not exceed an amount that will interfere with the consolidating properties of the fill material. No rocks or lumps shall come in direct contact with the pipe. Stones and lumps shall be kept separated and well distributed, and all voids shall be completely filled with fine material.

3.03 REMOVAL OF EXISTING MANHOLES

A. Existing manholes and structures to be removed shall be shown on the Drawings or as directed by the Purchaser. The City reserves the right to retain or reject salvage of any materials encountered. Unless otherwise specified, salvaged rims and covers remain the property of the City and shall be delivered by the Subcontractor to the City yard as directed by the Purchaser. All remaining materials become the property of the Subcontractor who shall be responsible for disposal.

3.04 GENERAL CONSTRUCTION REQUIREMENTS

A. New manholes and structures shall be constructed of plain or reinforced concrete. Where the top elevation is not shown on the Drawings, the manhole or structure shall be built to conform to the elevation of the existing final grade or as ordered by the Purchaser. Completion of the

manhole shall include the installation of fittings, connections to pipes, placing of castings, testing, and other construction as shown on the Drawings.

B. Inlet and outlet pipes shall extend through the walls of manholes to allow for water tight connections with the manhole walls. The ends shall be cut off flush with the inside surface of the wall as shown on the Drawings, design standards, or otherwise directed by the Purchaser. The pipes shall intersect at the structures so the inlet pipe will be aligned in the direction of outlet pipe such that counter-flow is prevented. Water stops shall be installed around pipes as they pass through the sanitary manhole wall.

C. Inverts shall be of Class A concrete poured to conform to the shapes shown on the Plans or otherwise directed. The inverts shall be constructed as to cause the least possible resistance to flow. The shape of the inverts shall conform uniformly to inlet and outlet pipes. A smooth and uniform finish shall be required.

D. Dewatering

1. Subcontractor shall furnish, install and operate pumps, pipes, appurtenances, and all equipment of sufficient capacity required to remove any groundwater encountered in the excavation. Subcontractor shall conduct said groundwater away from the construction site in an approved manner. Generally, dewatering is considered to be incidental to the construction of sewer manholes.

E. Bypass Pumping

1. Subcontractor shall furnish, install, and operate pumps, pipes, appurtenances, and all equipment of sufficient capacity required to maintain sewage flow around the work area. Subcontractor shall conduct said bypass pumping in an approved manner. Generally, bypass pumping is considered to be incidental to the construction of sewer manholes.

F. Traffic Control

1. All traffic control shall be installed and maintained in accordance with the Manual on Uniform Traffic Control Devices (MUTCD). At a minimum, the Subcontractor must have two trucks with flashing yellow lights on the work site. Traffic cones must also be placed downstream of the construction site to divert cars into the adjacent lane(s) per MUTCD requirements. On roads with heavy traffic volume, a flagman may also be needed to assist with traffic control. For bidding purposes, the Subcontractor should assume that a flagman will be needed on 30 percent of the setups.

3.05 INSTALLATION – PRECAST MANHOLES

A. Manhole Foundations

1. Precast concrete manholes shall be built according to the Drawings or as directed by the Purchaser. All precast manholes shall use either a concrete slab constructed of Class A concrete on a 12-inch thick No. 67 crushed limestone foundation and will be cast integrally with the base section and the inlet and outlet pipes as shown on the Drawings or the precast manhole shall use a precast base section conforming to this Specification. The stone base shall be fully encapsulated in a geotextile fabric as indicated on the plans or as directed by the Purchaser. The Subcontractor shall dewater sufficiently to maintain the ground water level at or below the bottom of the manhole foundation prior to and during placement of the foundation.

B. Manhole Installation on Existing Lines

1. For all lines 12 inches in diameter or less, a section of pipe shall be removed and a complete precast manhole installed. The existing pipes shall be joined by a flexible coupling to pipe extensions from the manhole. Minimum 4-foot pipe extension shall be required from manhole to connect to existing pipe.

C. Manhole Diameters

1. In general, the internal diameter of manholes shall be 4 feet.

2. Manhole diameter sizing, however, is contingent upon limitations of manufacturer due to pipe sizes and pipe deflections at manhole. Subcontractor shall verify proper manhole diameter is provided based on proposed manhole pipe configuration and pipe sizes indicated. Manhole sizing shall be approved by the Purchaser.

D. Frames and Covers

1. Cast iron frames and covers shall be set at the required elevation and properly bonded to the masonry with two rings of butyl mastic sealant and anchor bolts.

2. City Standard watertight frames and covers shall be used in flood prone areas, and areas where water ponds or could pond, including traffic areas.

a. Where shown on the Drawings, vent stacks shall be installed in long runs of sewers, potentially with watertight frames and covers. Vents shall be designed and constructed to preclude water entering the sewer system during storm events through the vents.

3. City Standard frame and cover obtained from Universal Scaffolding shall be used in all other areas.

4. Manhole rim elevations shall be set at grade in traffic areas and finished landscaped areas (finished grade is at the top of mulch in finished landscape areas), shall be set at 3 inches above grade in non-finished landscaped areas, and to be set at 2 feet or more above finish grade in non-traffic and non-landscaped areas.

5. Wherever manholes are constructed in paved areas, the top surface of the frame and cover shall conform to the exact slope, crown, and grade of the existing adjacent pavement.

3.06 PROTECTION OF DOWNSTREAM FACILITIES

A. The Subcontractor must take all steps necessary to assure that no material is allowed to fall into the line during his installation process. The Subcontractor shall bear all cost of repairs resulting from any damages to downstream facilities resulting from failure to abide by this stipulation.

3.07 WASTEWATER SPILLS

A. Should the Subcontractor spill any wastewater, such that the sewage either immediately or ultimately enters the waters of the State of Tennessee, then the Subcontractor shall be completely responsible for any fines or penalties imposed on the Purchaser or the Subcontractor by the USEPA or the State of Tennessee.

PART 4 MEASUREMENT & PAYMENT

4.01 MEASUREMENT

A. Precast Manhole Replacement

1. Precast manhole replacement will be measured per vertical foot of manhole from the downstream invert up to the bottom of the frame casting.

B. Precast Manhole Installation

1. Precast manhole installation will be measured per vertical foot of manhole from the downstream invert to the bottom of the frame casting.

C. Pavement Backfill

1. Pit run gravel or other acceptable material used for backfill under pavements or other areas directed by the Purchaser will be measured by the cubic yard. The backfill will extend 12 inches around the outside of the masonry or concrete work to allow for proper placement. No payment will be made for additional backfill used outside of 12 inches unless approved prior to completion by the Purchaser.

D. Traffic Control

1. Traffic control will be measured per each standalone manhole installed or replaced when not associated with an adjoining sewer segment being rehabilitated.

E. Dewatering

1. Dewatering is considered to be an incidental to sewer manhole rehabilitation.

F. Bypass Pumping

1. Bypass pumping is considered to be an incidental to sewer manhole installation and replacement.

4.02 PAYMENT

A. Precast Manhole Replacement

1. Precast Manhole replacement will be paid at the contract unit price per vertical foot, which shall be full compensation for the base, precast sections, adjusting rings, as needed, gaskets, steps, cast-in or core drilled pipe openings, pipe connectors, grout, manhole rims, frames, and covers, and vacuum testing, and removal and approved offsite disposal of materials, including manhole being replaced.

B. Precast Manhole Installation

1. Precast Manhole installation will be paid at the contract unit price per vertical foot, which shall be full compensation for the base, precast sections, adjusting rings, as needed, gaskets, steps, cast-in or core drilled pipe openings, pipe connectors, grout, manhole rims, frames, and covers, and vacuum testing, and removal and approved offsite disposal of materials.

C. Pavement Backfill

1. Accepted quantities of pit run gravel or other acceptable material used for backfill under pavements or other areas designated by the Purchaser will be paid for at the contract unit price per cubic yard furnished and placed, which will be full compensation for furnishing, placing and compacting the selected material.

D. Traffic Control

1. Traffic control will be paid per each manhole rehabilitated including all appurtenances required to comply with MUTCD standards. Only standalone manhole installation or replacement will include a separate traffic control payment. All traffic control for manholes with adjoining sewer segment rehabilitation will be included in the traffic control for the associated pipe.

4.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02531-4.01.A	PRECAST MANHOLE REPLACEMENT	VERTICAL FOOT
02531-4.01.B	PRECAST MANHOLE INSTALLATION	VERTICAL FOOT
02531-4.01.C	PAVEMENT BACKFILL	CUBIC YARD
02531-4.01.D	TRAFFIC CONTROL	EACH

END OF SECTION 02531

SECTION 02533
REHABILITATION AND REPAIR OF EXISTING MANHOLES

PART 1 GENERAL

1.01 SCOPE

A. This work shall consist of the repair and rehabilitation of existing sanitary sewer manholes as shown on the Drawings, stipulated in the Contract Documents, or as directed by the Purchaser. The construction will be accomplished by these Specifications and in conformity with the details shown on the Drawings or established by the Purchaser. The Subcontractor shall perform all work necessary to complete the Contract with the best modern practice. Unless otherwise provided, the Subcontractor is required to furnish all labor, materials, equipment, and incidentals required to rehabilitate or repair manholes as noted on the Drawings or directed by the Purchaser.

B. Accurately field measure and size each individual manhole. Each existing sewer manhole designated to be repaired or rehabilitated may have a different configuration and varying field dimensions.

C. Each manhole to be rehabilitated shall be thoroughly cleaned of all loose or missing bricks, loose mortar, holes, etc. shall be repaired. All leaks shall be plugged with active leak-stop material prior to manhole rehabilitation. The material for stopping leaks and repairing nonleaking holes, cracks, etc. in concrete and masonry manholes shall be compatible with the coating system used for rehabilitation.

D. The presence or absence of leakage through manhole walls noted on the manhole inspection reports and as seen in the Subcontractor's independent manhole inspections prior to bidding or construction depend on the groundwater levels and conditions at the time of the inspections. High groundwater levels in the project area typically occur in the dormant season (December through May), but will vary with rainfall in any given year and sewer location. Under certain circumstances, the groundwater currently entering the leaking sewer mains and laterals may migrate to the manholes after the sewer mains and laterals are rehabilitated or replaced. The Subcontractor shall reflect assumptions and judgments on leakage through manhole walls based on this information in the unit prices bid for lining manholes. All leakage shall be stopped prior to lining manholes. No additional payment will be made for repairing leaks not visible prior to bidding or sewer rehabilitation.

E. When applicable, the manhole lining shall not be installed until all main sewer lining and other manhole rehabilitation work is complete.

F. Where existing manholes are being repaired or rehabilitated, the Subcontractor shall arrange his work so that sewage flow will be maintained during the construction period with no discharge of sewage into an open trench, and no backup of sewage into the existing line. The Subcontractor shall provide necessary bypass pumping capacity to carry flow downstream of the manhole to be rehabilitated or repaired.

G. Replacement Manholes shall conform to Specification Section 02531.

H. Cast iron frames shall be set at the required elevation and properly bonded to the flat top, eccentric cone, or grade rings with two rings of butyl mastic sealant and anchor bolts as specified in Section 02532 Sanitary Sewer Manhole Adjustments.

I. Definitions/Standards

1. ASTM D-638: Test Method for Tensile Properties of Plastics.

2. ASTM D-695: Test Method for Compressive Properties of Rigid Plastics.

3. ASTM D-790: Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

4. ASTM D-4541: Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

5. ASTM D-412: Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

6. ASTM D-2240: Standard Test Method for Rubber Property Durometer Hardness

7. ASTM D-522: Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings

8. ICRI03732: Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays

J. Quality Assurance

1. The subcontractor shall furnish materials of quality required by the American Society for Testing and Materials (ASTM) standards and industry approved standards and specifications.

2. Provide guarantee against defective materials and workmanship in accordance with the requirements of these specifications.

K. Sequencing

1. All required interruptions of flow through manholes or any other portion of the sanitary sewer system shall be coordinated with the Owner and Purchaser, and approval must be received from the Purchaser prior to the interruption.

L. Substitutions

1. Should the Subcontractor wish to use any brand or type of material other than as specified herein, he shall so state in writing to the Purchaser naming the proposed substitution and manufacturer. This statement shall be accompanied by a certificate of compliance from an approved independent testing laboratory that the proposed substitute meets or exceeds the specified requirements and has been tested in accordance with the specified test standards. The statement shall also include documented proof that the proposed brand or type of material has a proven record of performance when used in the intended application as confirmed by actual field test or successful installations.

M. Samples

1. The Subcontractor shall apply the manhole lining system material on a sample area not less than four square feet (4 ft^2) in size. When approved, the sample area shall serve as a standard of acceptance for all further work.

1.02 SUBMITTALS

A. Unless otherwise specified, all sample submittals shall be delivered to the Purchaser within

two weeks of the NTP.

B. Site Subcontractor emergency phone numbers.

C. Schedules of work on a weekly basis that will be delivered no later than 2:00 PM on Thursday for the week following with daily AM email updates of approximate crew locations each day. Weekly schedule format shall contain a map, with sufficient streets labeled and identified at a scale to provide clarity, along with the nature and type of crew located by map area

D. Product Data on the following:

1. Crack and hole repair products

2. Cementitious plug material

3. Active leak-stop material

4. Frame and cover seals

5. Cementitious coating system including application requirements and chemical resistance data
6. Gasket polymer properties

E. Manufacturer's Certificate of Compliance for each type of product that product furnished meets requirements of this Section.

F. Manufacturer's written recommendations for product handling and installation.

G. Confined space entry plans.

H. Subcontractor shall submit to the Purchaser evidence indicating that the proposed applicators are fully qualified to perform the work, and any proposed applicator found to be not qualified shall (at the written request of the Purchaser) be removed forthwith by the Subcontractor.

I. The Coating Manufacturer shall warranty the entire project to include any and all aspects of the surface preparation, base material installation and protective coating applications for a period of ten (10) years from the date of acceptance by the Purchaser. The warranty shall make no distinction between installation practices and material performance and shall not be prorated with respect to elapsed time for the entire warranty period. Manufacturer shall, within a reasonable period of time after receipt of written notice thereof by the Purchaser [period not to exceed sixty (60) calendar days], repair defects in materials or workmanship during said TEN (10) year period, and any damage to other work caused by such defects or repairing of same at his own expense and without cost to the Purchaser.

1.03 DELIVERABLES

A. The Subcontractor shall provide post-rehabilitation MACP inspection for each manhole. Refer to Section 02544 Manhole GPS & MACP Inspection.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manhole Lining System

1. The manhole lining system shall be spray applied or centrifugally cast manhole coating

system.

2. The material applied onto the surface of brick or concrete manholes shall be a coating system consisting of a base coat and/or top coat to provide corrosion resistance within a sanitary sewer environment. The thickness of the base coat and top coat shall meet the manufacturer's recommendation. Where applicable, the coating shall be applied to the roof, fillets, hatch frames, and underside of hatch surfaces. Subcontractor can request to not use a base coat but must provide to the Purchaser evidence of successful installations of the product without using a base coat and its capability to properly adhere to the manhole wall and form a smooth finish on the wall, bench, and invert. In cases where the base coat is not used, the thickness of the top coating will be increased by the base coat thickness listed above.

3. The top coat applied shall be an approved polymer based polyurethane, a geopolymer, or a high-build solvent free epoxy product in conjunction with a high- strength cementitious repair/patch/base coat. The following products are acceptable and approved: Spectrashield Liner Systems, OBIC Armor 1000, Vortex Structure Guard, GeoKrete Geopolymer by Quadex, or EcoCast.

4. The installer shall warrant and save harmless the Owner and his Purchaser against all claims for patent infringement and any loss thereof. The Subcontractor shall handle and store all material and shall dispose of all wastes in accordance with applicable regulations.

5. Each system shall be designed for application over damp (but not active running water) surfaces without degradation of the final product and the bond between the product and the manhole surfaces. Active leaks shall be stopped using a premixed fast-setting, volume-stable waterproof cement plug consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents or urethane injection. It shall not contain chlorides, gypsum, plasters, iron particles, aluminum powder or gas-forming agents, or promote corrosion of steel it may come in contact with. Set time shall be approximately 1 minute. Ten-minute compressive strength shall be approximately 500 PSI.

6. All invert channels shall be coated with the protective top coat only to prevent infiltration and to build up the invert channel to the new sewer main invert elevations; to fill all voids, cracks, holes, etc.; and to form a smooth flow channel. The entire channel shall be coated. The coating thickness shall be in accordance with manufacturer's recommendations.

B. Mortar

1. Mortar shall be composed of one part Portland cement and two parts sand (volumetric measure) thoroughly mixed in a tight box, with water added gradually and mixed continually until mortar has attained the proper consistency for use in brick masonry; prepared only in such quantities as needed for immediate use; mortar mixed for more than 30 minutes, re-tempered, or previously set will not be allowed.

C. Butyl Mastic Sealant

1. The sealant shall be used when joining the casting frame to the existing manhole and for all manhole adjustments to provide a watertight structure. The sealing compound shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler, and shall contain no solvents, irritating fumes, or obnoxious odors. The compound shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. It shall be supplied in extruded

rope form of suitable cross section and in such sizes as to seal the joint space. Use two complete ropes at each joint. The sealing compound shall be protected by a suitable removable two-piece wrapper, which shall be designed so that half may be removed longitudinally without disturbing the other half in order to facilitate application of the sealing compound. The sealant shall also meet the requirements of the following table:

Composition	Test Method	Minimum	Maximum
Bitumen (Petroleum Plastic Content)	ASTM D4	50	70
Ash Inert Mineral Matter	AASHTO T11	30	50
Volatile Matter	ASTM D6	---	2.0
Property	**Test Method**	**Minimum**	**Maximum**
Specific Gravity at 77 degrees F	ASTM D71	1.2	1.3
Ductility at 77 degrees F(cm)	ASTM D113	5.0	---
Softening Point	ASTM D36	320 degrees F	---
Penetration 77 degrees F (150 gms) 5 sec.	ASTM D217	50	120

2.02 EQUIPMENT

A. The Subcontractor shall furnish and maintain in good condition all equipment and facilities as required for the proper execution and inspection of the Work. All equipment and facilities shall be on site and approved by the Purchaser before work will be permitted to begin.

PART 3 EXECUTION

3.01 PRELIMINARY AND GENERAL ITEMS

A. Notification of Work

1. The Subcontractor shall notify all property owners who discharge sewage directly to the manhole being rehabilitated that their service will be discontinued while the work is completed. The Subcontractor shall notify individual property owners at least 72 hours in advance, giving the date, start time, and estimated completion time for the work being conducted. This notification shall be coordinated with the door hanger distribution.

B. Traffic Control

1. All traffic control shall be installed and maintained in accordance with the Manual on Uniform Traffic Control Devices (MUTCD). At a minimum, the Subcontractor must have two trucks with flashing yellow lights on the work site. Traffic cones must also be placed downstream of the construction site to divert cars into the adjacent lane(s) per MUTCD requirements. On roads with heavy traffic volume, a flagman may also be needed to assist with traffic control. For bidding purposes, the Subcontractor should assume that a flagman will be needed on 30 percent of the setups.

C. Fall Protection

1. The Subcontractor shall install and maintain all fall protection measures in accordance

with OSHA standards and the SARP10 Loss Control Manual. The Subcontractor shall construct a controlled access zone around the manhole being rehabilitated, repaired or adjusted. At a minimum, the fall protection zone shall include traffic cones encircled with pennant tape. The controlled access zone must have one point of access with an entrance log.

D. Cleaning/Surface Prep

1. All manholes to be rehabilitated shall be thoroughly cleaned before rehabilitation. All grease, oil, laitance, coatings, loose bricks, mortar, unsound concrete and other foreign materials shall be completely removed. Debris resulting from cleaning shall be removed from the manhole and not allowed to be carried downstream.

E. Flow Control

1. The Subcontractor shall be responsible for plugging or diverting the flow of sewage as needed for repair and coating of manhole inverts and benches.

F. Bypass of Flow

1. As required for acceptable completion of the work and/or to avoid damages due to sewer spills or overflows, the Subcontractor shall provide for sewer flow maintenance around the manholes designated for rehabilitation. The bypass shall typically be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent sanitary sewer system. The pump and bypass lines shall be of adequate capacity and size to handle the anticipated flow. Bypassing of sanitary sewage into the storm water system will not be allowed. For all bypass pumping, pump noise shall be kept to a minimum to the satisfaction of the Purchaser. The Subcontractor shall be required to contact all residential and commercial customers whose service lines connect to the sewer main being bypassed and inform them that they will be temporarily out of service. The Subcontractor shall also advise those customers against water usage until the mainline is back in service. After completing the necessary work on the main line, the Subcontractor shall advise those customers that the sewer main is back in service.

2. Bypass pumping is defined as providing pumps, standby pumps, piping, elevated structural support for aerial crossings, manpower to operate, routine maintenance and repair capability, pipe plugs, fuel, route and pump site clearing and any other work necessary to provide a complete bypass pumping operation. Any structures proposed by the Subcontractor for construction over or penetration into the interceptor piping for the purpose of performing the bypass operations must be approved by the Purchaser prior to implementation. The Subcontractor shall submit design drawings and details that are signed and sealed by a professional engineer licensed in the State of Tennessee. All bypass pump schemes must be submitted to and approved by the Purchaser in advance.

3. Public advisory services shall be required to notify all parties whose service laterals will be out of service and to advise against water usage until the mainline is back in service.

4. The Subcontractor shall be required to provide businesses with temporary service, as needed, and will be responsible for all necessary bypass pumping flows.

G. Wastewater Spills

1. Should the Subcontractor spill any wastewater, such that the sewage either immediately or ultimately enters the waters of the State of Tennessee, then the Subcontractor shall

be completely responsible for any fines or penalties imposed on the Purchaser or the Subcontractor by the USEPA or the State of Tennessee.

3.02 MANHOLE REHABILITATION – CEMENTITIOUS COATINGS

A. The surface prior to spraying shall be damp without noticeable water droplets or running water. Materials shall be spray applied to a minimum uniform thickness to ensure that all cracks, crevices, and voids are filled and a smooth surface remains after light troweling. The Subcontractor shall perform light troweling to compact the material into voids and to set the bond, where applicable.

B. Existing manhole steps shall be cut and removed prior to coating. Manhole steps are not to be replaced.

C. The first application shall have begun to take an initial set (disappearance of surface sheen which could be 15 minutes to one hour depending upon ambient conditions) before the second application to ensure a minimum total finished thickness of 1/2 inch. The final finished thickness may need to be greater than 1/2 inch in accordance with the manufacturer's recommendations to withstand groundwater pressures. A depth gauge shall be used during application, at various locations, to verify the required thickness. The surface then shall be troweled to smooth finish with care taken not to over trowel so as to bring additional water to the surface and weaken it. Manufacturer's recommendation shall be followed whenever more than 24 hours have elapsed between applications.

D. The bench covers used to catch debris shall be removed and the bench and invert sprayed such that a gradual slope is produced from the walls to the invert with the thickness at the edge of the invert being no less than 1/2 inch. The wall-bench intersection shall be rounded to a uniform radius the full circumference of the intersection.

E. No application shall be made to frozen surfaces or if freezing is expected to occur within the manhole for 24 hours after application. If ambient temperatures are in excess of 95°F, precautions shall be taken to keep the mix temperature at time of application below 90°F, using ice if necessary.

F. The final application shall have a minimum of four (4) hours cure time before subjected to actual flow.

3.03 INVERT AND BENCH REPLACEMENT

A. Remove all loose grout and rubble from existing channel. Replace the invert and bench by removing the existing invert and bench and reconstructing with concrete conforming to Section 03050 Portland Cement Concrete. Work shall include aligning inflow and outflow ports in such a manner as to prevent the deposition of solids at the transition point. All inverts shall follow the grades of the pipe entering the manhole. Changes in direction of the sewer and entering branch or branches shall have a true curve of as large a radius as the size of the manhole will permit, but shall be shaped to allow easy entrance of maintenance equipment including buckets, T.V. camera, etc. Benches shall be constructed to the highest pipe crown elevation and sloped to drain toward the flow-through channel.

B. Apply a minimum ½-inch finished thickness of cementitious liner material over the surface of the replaced invert and bench where cementitious coating is noted on Drawings or directed by the Purchaser. Allow the liner material to cure for a minimum of four hours before being subjected to flow.

3.04 RESET AND RESEAL MANHOLE FRAME AND COVER

A. If the existing manhole frame is misaligned on the manhole, the Subcontractor shall remove the existing manhole frame and cover and, if they are not being reused, dispose of them as directed by the Purchaser. It shall be the responsibility of the Subcontractor, at no additional cost to the Purchaser, to repair any damage to the chimney or corbel caused by the removal of the existing manhole frame. Existing frames and covers that are to be reused shall be thoroughly cleaned before reinstallation.

B. If the manhole frame is to be raised, the work shall be performed in conformance with Section 02532 of the City of Memphis Standard Construction Specifications modified by the SARP10 Program.

C. The manhole frame for the cover shall be set on the manhole sidewall in a full bed of flexible butyl resin gasket material at the required elevation. In addition, the frame shall be bolted to the grade rings. Where manholes are constructed in paved areas or fill slopes, the surface of the frame and cover shall be tilted so as to conform to the exact slope, crown, and grade of the existing pavement or area adjacent thereto.

D. Any new manhole frame and cover replacement shall result in a minimum 24 inches diameter clear opening to the manhole.

3.05 SEWER MANHOLE DROP CONSTRUCTION

A. Inside drop structures shall be installed in existing manholes at the locations shown on the Drawings and/or as directed by the Purchaser. Drop construction shall conform to the details shown on *Sanitary Manhole Drop Construction* Detail. The Subcontractor shall cut a hole in the manhole wall to permit inserting the inlet pipe at the required flow line elevation, horizontal angle, and slope, and to allow two (2) inches space around the pipe for bedding and filling solidly with nonshrinking grout. Care shall be used to avoid unnecessary damage to the existing masonry or concrete. Drop structure construction shall be installed before cementitious coating is applied where shown on the Drawings or directed by the Purchaser.

B. All loose material shall be removed from the cut surfaces, which shall be completely coated with grout before setting the pipe. Before inserting the pipe and flexible connector, a sufficient thickness of grout shall be placed at the bottom and sides of the opening for proper bedding of the pipe. After setting, all spaces around the pipe shall be solidly filled with grout and neatly pointed up on the inside to present a smooth joint, flush with the inner and outer wall surface. Any necessary modifications to the existing invert shall be made to provide a smooth, plastered surface for properly channeled sewage flow from the new connection. All drop construction shall be constructed of either ductile iron pipe with push on or mechanical joints or PVC pipe. Solvent cement joints may be used on PVC for drop construction. The vertical drop construction shall have the dead weight held by suitable means until the steel support straps are secured in place and tightened. The pipe mechanical joint bolts, if used, shall not be positioned against the manhole wall. The steel support straps shall be fastened to the manhole wall with two bolts per strap set in expansion sleeves in drilled holes.

3.06 MANHOLE REHABILITATION ACCEPTANCE

A. After the manhole rehabilitation work has been completed, the manhole shall be visually inspected by the Subcontractor in the presence of the Purchaser's Representative, and the work shall be accepted if found satisfactory to the Purchaser's Representative. When a cementitious coating is applied, the finished surface shall be free of blisters, "runs" or "sags" or other indications of uneven coating thickness. No evidence of visible leaks shall be allowed.

B. Vacuum Testing will be required for all manholes that receive a cementitious coating. The vacuum testing method shall be conducted as follows:

1. Subcontractor shall plug all pipe openings, taking care to securely brace the plugs and the pipe. The plugs shall be placed a minimum of 6 feet beyond the manhole wall.

2. With the vacuum tester in place, the Subcontractor shall inflate the compression to affect a seal between the vacuum base and the structure. The Subcontractor shall connect the vacuum pump to the outlet port with the valve open and evacuate the manhole to 10-inches Hg (0.3 bar) for 48 inch diameter manholes and 5-inches Hg (0.15 bar) for 60-inch and greater diameter manholes.

3. Subcontractor shall close vacuum inlet/outlet ball valve, disconnect the vacuum pump, and monitor the vacuum for the specified time period. If the vacuum does not drop in excess of 1-inch Hg over the specified time period, the manhole is considered acceptable and passes the test. If the manhole fails the test, The Subcontractor shall identify the leaking areas by removing the head assembly, coating the interior surfaces of the manhole with a soap and water solution, and repeating the vacuum test for approximately thirty seconds. Once the leaks have been identified, the Subcontractor shall complete all necessary repairs by sealing the leaks of the manhole to the satisfaction of the Purchaser's Representative, and repeat test procedures until satisfactory results are obtained.

Vacuum Test Timetable

	Manhole Diameter (Inches)		
Depth (Feet)	**48"**	**60"**	**72"**
4'	10 sec.	13 sec.	16 sec.
8'	20 sec.	26 sec.	32 sec.
12'	30 sec.	39 sec.	48 sec.
16'	40 sec.	52 sec.	64 sec.
20'	50 sec.	65 sec.	80 sec.
24'	60 sec.	78 sec.	96 sec.
*	5.0 sec.	6.5 sec.	8.0 sec.

*Add extra testing time "T", for each additional 2-foot depth. (The values listed above have been extrapolated for ASTM designation C924-85.

4. The Purchaser reserves the right to reject any and all manholes that do not pass vacuum testing requirements, and replacement shall be at the Subcontractor's expense. A significant number of leaks on a single manhole or significant number of manholes leaking shall be considered as a basis for rejection and replacement of manholes.

5. Where vacuum testing is not applicable, the Subcontractor shall be directed by the Purchaser to conduct a high-voltage holiday test.

3.07 WARRANTY AND GUARANTEE FOR REHABILITATED MANHOLES

A. The Subcontractor shall guarantee the rehabilitated manholes for ten (10) years after acceptance by the Purchaser to the extent that he will repair any leaks that may appear in them during this period because of faulty workmanship or materials furnished by him at no additional expense to the Owner. As required by 2.01.A.9, the Subcontractor shall also have written documentation that the Coating Manufacturer provides a ten (10) year warranty for all manholes receiving a cementitious coating.

PART 4 MEASUREMENT & PAYMENT

4.01 MEASUREMENTS

A. Manhole Rehabilitation – Cementitious Coating

1. Cementitious coating will be measured per vertical foot of manhole from the downstream invert up to the bottom of the frame casting.

B. Sewer Manhole Drop Construction

1. Drop construction in existing manholes will be measured per vertical foot as measured from the upper inlet pipe flowline to the flowline of drop pipe elbows at the bottom of the drop construction

C. Invert and Bench Replacement

1. Invert and bench replacement will be measured per each.

D. Reset and Reseal Manhole Frame and Cover

1. Manhole frame and cover rehabilitation will be measured per each.

E. Sewer Manhole Drop Construction

1. Drop construction in existing manholes will be measured per vertical foot as measured from the upper inlet pipe flowline to the flowline of drop pipe elbows at the bottom of the drop construction.

F. Traffic Control

1. Traffic control will be measured per each standalone manhole being rehabilitated when not associated with an adjoining sewer segment being rehabilitated.

G. Bypass Pumping

1. Bypass pumping is considered to be an incidental to the sewer manhole rehabilitation.

H. Dewatering

1. Dewatering is considered to be an incidental to sewer manhole rehabilitation.

4.02 PAYMENTS

A. Manhole Rehabilitation - Cementitious Coating

1. Cementitious coating of manholes will be paid for at the contract unit price per vertical foot which shall be compensation for surface preparation, sprayed on lining, removal and disposal of manhole steps, and vacuum testing.

B. Sewer Manhole Drop Construction

1. The accepted quantities of sewer manhole drop construction will be paid for at the contract unit price per vertical foot, complete in place for drop construction in new manholes or drop construction in existing manholes, which will be full compensation for materials and materials testing, excavation, special protection, maintenance of sewage flow during construction, construction of drop pipe, pipe fitting and connections, installation of steel support straps, placement, curing, and protection of concrete from the manhole base to the top of drop construction, cleaning and inspection, and backfilling outside of pavement areas. Payment for drop construction for new manholes will be in addition to payment for standard depth manhole and extra depth construction (if required).

C. Invert and Bench Replacement

1. The accepted quantities of invert and bench replacement will be paid for at the contract unit price per each. It shall include all work and material to install new inverts in existing manholes, as directed by the Purchaser.

D. Reset and Reseal Manhole Frame and Cover

1. The accepted quantities for frame and cover rehabilitation will be paid for at the contract unit price per each.

E. Traffic Control

1. Traffic control will be paid per each manhole rehabilitated including all appurtenances required to comply with MUTCD standards.

4.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02533-4.01.A	MANHOLE COATING	VF
02533-4.01.B	DROP CONSTRUCTION IN EXISTING MANHOLE	VF
02533-4.01.C	INVERT AND BENCH REPLACEMENT	EACH
02533-4.01.D	RESET/RESEAL MANHOLE FRAME AND COVER	EACH
02533-4.01.E	TRAFFIC CONTROL	EACH

END OF SECTION 02533

SECTION 02544
MANHOLE GPS & MACP INSPECTION

PART 1 GENERAL

1.01 SCOPE

A. This Work shall consist of locating sanitary sewer system facilities, gathering sub-meter grade GPS coordinates of manhole (including lamphole) covers, Manhole Assessment Certification Program (MACP) protocol Level 1 and Level 2 manhole inspections using the National Association of Sewer Service Companies (NASSCO) MACP Version 6.0.1 protocols, associated photographs, camera inspection of manholes and the associated pipe connections, and documentation of manholes not found, not on grade and/or not showing. The work shall also consist of completing an internal 3D manhole scan for each manhole with a depth greater than 25 feet or associated with large-diameter sanitary sewer interceptors (36-inch diameter and larger). Manholes to be located, documented and inspected are in both improved streets, arterial and primary roads, backyards and unimproved easements. Manholes may be elevated significantly above the existing ground level. Subcontractor shall have appropriate all-terrain vehicles necessary to access the work, in addition to any equipment necessary to access all elevated manholes while remaining in compliance with The Loss Control Manual. Once new manhole coordinates are obtained, the updated source GIS map data shall be delivered to Program Manager in order to reflect the actual sewer system network.

B. The Work covered by this section includes furnishing all labor, competent MACP certified technicians/crew leads, equipment, tools, accessories, and materials required to GPS, perform MACP Level 1 and Level 2 inspections, conduct 3D scan camera inspections where applicable and document the specified manholes.

C. Selected Subcontractor(s) will be provided two Geo-databases; one will have supporting records (aerial photo overlays, outfall and block maps and as-builts, as available), and a maiden database which will include the asset ID for each manhole.

1.02 SUBMITTALS

A. GPS Requirements

1. Sub-meter GPS coordinates, updated GIS map data, Levels 1 and 2 MACP data and records, and camera inspection photos and 3D scan of the manholes shall be delivered to the Program Manager on clearly labeled external hard drive(s) which will become property of the Program Manager. Inspection data for any one asset shall not be delivered on multiple drives. MACP data files shall be formatted to facilitate upload into a MACP Exchange Database or internet upload to an FTP site as approved by the Program Manager.

B. Unless otherwise specified, all sample submittals shall be delivered to the Program Manager within two weeks of the NTP.

C. For rehabilitation jobs, only Post-Rehabilitation MACP submittals will be required by the Purchaser.

D. Traffic Control

1. A Traffic Control Plan shall be submitted to the Program Manager, including the following items:

a. Outline of permit acquisition procedure for lane closures.

b. Methods for proper signing and barricades, which comply with local requirements and the City.

c. Major streets (e.g. Shelby County Principal Arterial & Minor Arterial) requiring a City approved permit if taking a lane for mobile operations, secured through Traffic Control Plan submittal to the City and signed by a TN P.E. The City requires a two-week lead time for permit processing.

i. The Subcontractor will be required to deliver a sample primary/arterial road Traffic Control Plan for review by the City.

ii. If the City determines that the nature of the work operation or the type of road in which the Subcontractor is working requires a permit, the Subcontractor will be required to modify the sample Traffic Control Plan to obtain a permit from the City.

d. For everywhere else where a permit is not required, the Subcontractor shall develop, provide, and implement a Traffic Control Plan for all mobile operations in accordance with standard MUTCD specifications.

E. Permits

1. The Subcontractor is also responsible for acquiring all necessary disposal and/or landfill site permits required to perform this work.

2. Railroad Rights of Way: The Subcontractor shall notify the Program Manager when work or access to manholes and sanitary sewers lie within the 25 feet railroad easement, as measured by 25 feet outside the nearest rail of the tracks. To access sewer facilities within the 25 feet of the railroad right of way, the Subcontractor shall contact 48 hours in advance the Program Manager, who will alert the City's Zone Construction Inspector to coordinate individual railroad direction and guidance.

3. Permit required confined space entry plans in compliance with the Loss Control Manual.

F. GPS calibration standards, including frequency, are to be followed in the field; specify which available base stations will be used for the work.

G. Sample of sub-meter GPS coordinates delivered in electronic and pdf format.

H. Copies of NASSCO certifications for all field staff conducting MACP Levels 1 and 2 inspections.

I. Sample of MACP Level 1 and Level 2 documentation logs (with photo documentation comments and photos properly referenced) in MACP formats, in both electronic and pdf format.

J. Equipment list, including GPS and 3D camera manufacturer and model equipment to be used.

K. Sample of the GPS coordinate delivery in an ESRI ArcPAD.axf file format.

L. Sample of the digital inspection data delivery in MS ACCESS database format.

M. Sample of 3D manhole inspection and all software necessary to view inspections.

1.03 DELIVERABLES

A. Records

1. GPS Manhole Cover Coordinates

a. Subcontractor's Level 1 Lamphole and Level 2 Manhole GPS coordinate delivery to the Program Manager shall be in an ESRI ArcPAD.axf file format. The updated GIS source map data reflecting the actual sewer system network shall also be delivered. Inspection data is to be delivered to the Program Manager by the close of business on the Monday following a week after data acquisition. Subsequent data will not be accepted if GPS data is not obtained and delivered at the same time as inspection is conducted. The requested GPS control check file (MS EXCEL) shall also be delivered at this time.

2. Level 1 and Level 2 Inspection Documentation

a. Deliver complete MACP Level 1 for lampholes and Level 2 inspections for manholes in MACP electronic database and pdf electronic formats on an external hard drive. Delivery will be in MS ACCESS database format unless otherwise preapproved by the Program Manager. Inspection data is to be delivered to the Program Manager by the close of business on the Monday following a week after data acquisition.

3. 3D Camera Inspection

a. For manholes greater than 25-feet in depth or associated with lines 36-inches or greater in diameter, the Subcontractor shall provide the Program Team with the software required to view the digital film file in the way the Subcontractor can view it, including full control of the virtual pan and tilt. The digital files must include the following:

i. An unfolded view of the manhole with a minimum of 3,000 lines of vertical resolution.

ii. The capability to produce three-dimensional representation of the manhole structure.

iii. A distortion-free virtual pan and tilt allowing the review of the manhole structure from any angle at any depth. The virtual pan and tilt must consist of view from the bottom and top camera, any virtual pan and tilt that artificially creates this view from a single camera will be deemed unacceptable due to distorted images on the direct side view.

2. Camera Inspection Documentation

a. Include specified camera photo documentation of defects, leaks and pipe connections in the MACP Image reference field as appropriate, for the Level 2 documentation. Inspection data is to be delivered to the Program Manager by the close of business on the Monday following a week after data acquisition.

3. Manhole Reports

a. Deliver a summary report in PDF format of each manhole inspected. The report will include all MACP Level 1 & Level 2 data collected for the manhole. The report shall include the surface view photo of the manhole with the outlet pipe facing 6 o'clock as

well as a downhole photo of the channel with the outlet pipe at 6 o'clock. Any defects noted in the manhole shall also have an accompanying photo in the report.

4. Draft Report and Final Report

    a. In addition to the electronic database and pdf format reports, three copies of the Draft Report will contain hard copies of each of the MACP inspections with camera manhole defect and pipe connection photographs. The MACP compliant database of the inspections in ACCESS format shall also be submitted to the Program Manager electronically on an external hard drive.

    b. Draft Report shall be delivered to Program Manager within fifteen working days of the last or final inspection. The Program Manager will have a two-workweek period to review and provide comments to the Subcontractor. The Subcontractor shall address all comments and submit the Final Report within one workweek from receipt of comments. At the Program Manager's discretion, a meeting will be held upon submittal of the Final Report to have the Subcontractor go over the processes used to address comments.

5. Quality

    a. Rejection of deliverables will be submitted to the Subcontractor via the Program Team in a written communication discussing issues that must be addressed. The Subcontractor will be required to follow up with a response within three business days upon receipt of the written communication. Subcontractors will have seven (7) calendar days from the rejection notice date to make the necessary corrections and resubmit the data deliverable in its entirety.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Subcontractor shall have appropriate all-terrain vehicles necessary to access the work. Expected terrain may require the use of four-wheel drive vehicles, ATVs, tracked vehicles, or other appropriate off-road vehicles. Additionally, the Subcontractor shall have all equipment necessary to access elevated manholes in accordance with the Loss Control Manual.

B. All equipment used for the gathering of GPS coordinates, collection of condition assessment information, and digital 3D camera inspection of manholes shall be specifically designed and manufactured for the purpose intended under this Contract. The software and hardware for the electronic capture of the inspection defect observations must be consistent with NASSCO's MACP Level 1 and Level 2 requirements for the collection of data. ESRI ArcPad 10.1 is required for GPS data collection and GIS map updates for manhole / lamphole facility locations. Export of the electronic inspection data to an MACP format Microsoft ACCESS database for analysis is required.

C. The Subcontractor shall submit an equipment list to the Program Manager for approval before the commencement of the Work and shall certify that back-up equipment is available and can be delivered to the worksite in 72 hours.

1. GPS Equipment

    a. GPS Equipment shall be sub-meter grade, Trimble Pro Series Receivers with Floodlight technology capability, Top Con GRS-1 Series equipment or equal (to be approved by Program Manager prior to mobilization). GPS coordinates to be real-time or post-processed to achieve sub-meter accuracy. Equipment must have ESRI ArcPad 10.1 installed for use in data acquisition.

2. Camera

   a. All camera systems used shall be digital format. The camera must have two independently or simultaneously controlled digital cameras, one facing in the downward direction and one facing in the upward direction. Each camera must have a minimum of 185-degree field of view. The inspection camera system must illuminate the interior of the manhole using a xenon strobe light. The light shall be positioned 360 degrees around the camera lens to distribute the light evenly onto the structure walls. The lighting must be able to illuminate manholes up to 120" in diameter without the need of any auxiliary lighting.

   b. A camera must also be able to obtain still images of the following specified pictures: Photo 1- surface view photos taken of the manhole should include a whiteboard (or similar) with the manhole ID number identified on it. The photographer should be standing with the outlet pipe facing their 6 o'clock position. Photo 2 - the downhole photo of the manhole channel should be taken with the outlet pipe facing their 6 o'clock position. Additional photos as specified by MACP guidance. The camera used for these images must be minimum 5 megapixel .jpg format for sufficient clarity and detail in the photos, and photos of at least 2 MB shall be submitted. If the 3D scan camera system cannot obtain photos of sufficient quality, a pole-mounted digital camera with lighting shall be used for the specified pictures in this paragraph.

   c. The 3D camera system shall produce individual images or frames with no more than 0.001 inches of movement during image or frame exposure to produce crisp, clear images. The inspection camera must provide a minimum of 3,000 lines of vertical resolution in the side view and a minimum of 500 lines in the perspective view.

   d. Inadequate lighting, image distortions, blurry or murky images, low resolution, dirty lens and/or other quality issues will be a cause for rejection. If unsatisfactory, Subcontractor shall perform work until deliverable is of acceptable quality. No payment will be made for unsatisfactory inspections or until submittal is accepted.

3. Data Logger and Software

   a. MACP inspections and logs created and captured electronically during the MACP inspection of the manhole through the use of commercially available electronic data loggers are required. Paper records for data collection in the field shall not be used. NASSCO MACP protocols shall be used for capturing and recording the observations.

   b. The data logger equipment and software shall allow Program Manager direct access to the captured electronic data, and provide for export of the data in accordance with MACP formats and standards.

4. Retrieval of Stuck Equipment

   a. The Subcontractor is responsible for hiring a licensed sub-Subcontractor to retrieve any equipment that becomes lodged in the sewer system through the execution of the scope of work (fallen cameras, jet nozzles, inflatable plugs, sandbags etc.) at the Subcontractor's own cost. Such retrieval by an appropriately licensed sub-Subcontractor shall be made within 72 hours to avoid interfering with the City of Memphis sewer system operations. Any and all impacts and related costs due to the Subcontractor's equipment in the line shall be the responsibility of the Subcontractor.

PART 3 EXECUTION

3.01 INSPECTION

A. GPS Coordinates of Manhole Cover

1. Program Manager will provide Subcontractor with a digital copy of the original GIS source map indicating the sewer system network compiled from existing City records.

2. The Subcontractor shall capture and record sub-meter grade x, y and z coordinates of each manhole cover identified in the original GIS maiden data map provided with a unique asset identification (ID) number. Additional sanitary sewer lamphole and manholes found in the field in the course of the inspection work that are not provided in current mapping nor identified with a current unique asset ID shall be documented and GPS coordinates shall be recorded. A provisional manhole asset ID number shall be used by the Subcontractor by adding a dash and a two-character number to the closest upstream manhole ID.

3. Record sub-meter GPS coordinates in NAD83 TN State Plane Coordinates horizontal, NAVD88 vertical in US Survey feet using properly-calibrated GPS equipment. If GPS coordinates cannot be obtained due to buildings, trees or cloud cover, Subcontractor shall note this on the inspection form and return at least one additional time at a different time of day or under different sky cover. If both attempts fail at securing the sub-meter coordinates, this is to be documented and reported in the submittal. Land surveying shall not be required where GPS is not available.

4. The Subcontractor shall be expected to use all reasonable means to locate the lampholes and manholes in the field. This includes walking the pipeline alignment, using measuring tapes or wheels from the last found manhole, using metal detectors, or other means. If manholes are not able to be found and documented or unknown manholes are found, record the reasons for not locating or not opening the manhole or the specifics of the new manhole found, and submit with supporting MACP documentation to the Program Manager daily.

5. Once GPS coordinates are obtained for known and newly discovered facilities, the original GIS map data shall be delivered to the Program Manager to reflect the actual sewer system network for the assigned inspection area.

6. The Subcontractor shall revisit predefined GPS control locations near project area at least one time per day per each GPS unit used as a quality control check on GPS accuracy. Subcontractor is to document these checks on a single log, which shall be kept on file for the duration of the project, and shall be released to Program Manager on a weekly basis.

B. MACP MH Inspection

1. The Subcontractor shall document and record each sanitary sewer manhole inspection in MACP Level 1 format for lampholes and Level 2 format for manholes with supporting completed MACP format database. The complete NASSCO MACP Levels 1 and Level 2 protocols must be utilized for the lamphole and manhole inspections respectively, and must be associated in the electronic database and pdf documentation with the unique asset ID provided.

2. The Subcontractor shall mark the direction of wastewater flow (one arrow per pipe) in and out of the manhole around the perimeter of the manhole cover on the street with discrete

green arrows spray painted onto the road surface using a guide or template for the arrows. The arrows shall be a minimum of 12 inches and a maximum of 18 inches in length.

3. The Subcontractor shall follow the prescribed MACP Level 1 and Level 2 procedures and use the required nomenclature and formats to document the manhole interior and exterior conditions and defects.

4. Subcontractor shall be responsible for cleanup, repair, fines, property damage costs, and claims for any sewage backup, spillage or sanitary sewer overflow during or as a result of the field operations.

C. Camera Inspection of Manholes and Associated Pipe Connections

1. For manholes greater than 25-feet in depth and manholes associated with lines 36-inches and larger in diameter, a 3D manhole scan shall be completed in conjunction with Level 2 manhole inspections of defects and include each sewer pipe connection in the manhole. The photo record of the inspection shall document defects and leaks and shall include a photo record of the connecting pipes in each manhole. Abbreviations, naming conventions, and numbering conventions shall be documented in MACP formats.

2. File naming must be consistent. Additional instructions, naming conventions, file structures, etc. will be provided after contract award.

D. Incident Observation and Data Collection

1. The Subcontractor shall report all Unable to Complete and surcharged manholes to the Program Manager through the program-defined reporting application (Teamworx) and shall fill out all required fields and attach picture documentation as necessary. For a surcharged manhole, at least one picture shall be included to document the level of surcharge. All reported incident observations will be monitored by the Program Manager and inadequate reporting will result in a meeting between the Program Manager and Subcontractor.

PART 4 MEASUREMENT and PAYMENT

4.01 MEASUREMENT

A. GPS Coordinates of Manhole Cover

1. The capture and associated documentation of sub-meter GPS x, y and z coordinates for each lamphole and manhole cover will be measured for payment per each lamphole and manhole located by GPS and its coordinates recorded in accordance with the specification, provided that documentation meets QA/QC standards.

B. MACP Level 1 for Lamphole Inspections

1. The inspection and recording of all lamphole observations in a MACP compliant fashion will be measured for payment per each lamphole inspected in accordance with the specification.

C. MACP Level 2 for Manhole Inspections

1. The inspection and recording of all manhole observations in a MACP compliant fashion will be measured for payment per each manhole inspected in accordance with the specification. For manholes greater than 25-feet in depth or associated with lines 36-

inches in diameter or greater, a 3D manhole scan shall be included as part of the MACP Level 2 inspection.

4.02 PAYMENT

A. GPS Coordinates of Manhole Cover

1. The capture and associated documentation of sub-meter GPS x, y and z coordinates for each manhole cover shall be paid for at the unit price bid for each lamphole and manhole cover coordinates documented and recorded in accordance with the specification provided that QA/QC standards are met.

2. The unit price for each manhole cover GPS set of coordinates shall cover the entire cost of the GPS equipment and time necessary to gather the coordinates, including but not limited to calibrating the equipment; setup and access; traffic control; documenting results in prescribed MACP electronic formats, records and logs; power supply for equipment; interim and final reports; and all other appurtenant work.

3. No additional payment will be made for:

   a. Location or re-inspection due to cars parked over manholes or other impediments to on grade and showing manhole covers.

   b. Additional visit(s) to secure the proper GPS coordinates due to lack of adequate satellite coverage or reception.

B. MACP Level 1 for Lamphole Inspections

1. The inspection and recording of all lamphole observations in a MACP format shall be paid for at the unit price bid per each MACP Level 1 inspection performed in accordance with the specification, provided that QA/QC standards are met.

2. The unit price for each MACP lamphole inspection shall cover the entire cost of the inspection and reporting, including but not limited to setup and access, documenting results in records and logs, power supply for equipment, interim and final reports and all other appurtenant work.

C. MACP Level 2 for Manhole Inspections

1. The inspection and recording of all manhole observations in a MACP format shall be paid for at the unit price bid per each MACP Level 2 inspection performed in accordance with the specification, provided that QA/QC standards are met.

2. The unit price for each MACP manhole inspection shall cover the entire cost of the inspection and reporting, including but not limited to setup and access, documenting results in records and logs, digital photos, power supply for equipment, interim and final reports, and all other appurtenant work. This also includes the materials and labor to complete 3D scan of the manhole with all associated deliverables where applicable.

4.03 PAYMENT WILL BE MADE UNDER

Item No.	Pay Item	Pay Unit
02544-4.01.A	GPS COORDINATES OF MANHOLE COVER	EACH
02544-4.01.B	MACP LEVEL 1 LAMPHOLE INSPECTIONS	EACH
02544-4.01.C-1	MACP LEVEL 2 MANHOLE INSPECTIONS-NO 3D SCAN	EACH
02544-4.01.C-2	MACP LEVEL 2 MANHOLE INSPECTIONS WITH 3D SCAN	EACH

END OF SECTION 02544

SECTION 02630
SITE PREPARATION AND RESTORATION

PART 1 GENERAL

1.01 SCOPE

A. This Work shall consist of the removal of brush, rubbish, fences, structures, abandoned appliances, building foundations, all trees, shrubs and plants not to be protected, and all other obstacles within the right-of-way / easement limits shown on the Plans and/or in the Special Instructions; the disposal of debris; and the restoration and/or protection of trees, shrubs, plants, fences, turfed areas, and structures after construction of drainage facilities is completed.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. All equipment for the satisfactory performance of the work shall be on the project and approved before the work will be permitted to begin.

PART 3 EXECUTION

3.01 RIGHT-OF-WAY AND EASEMENT

A. The Subcontractor shall confine his construction activities within the rights-of-way and/or easements as shown on the Plans and easement/rights-of-way plats provided by the owner. The Subcontractor shall be responsible for obtaining written agreements for use of private property outside of City of Memphis acquired rights-of-way/easements for such purposes as storage of material and equipment and access to the construction site. The Subcontractor shall provide a copy of all such written agreements to the Purchaser immediately upon obtaining the necessary documentation.

3.02 EXISTING OBSTRUCTIONS

A. Where applicable, locations of obstructions shown on the Plans are approximate and are shown only for information purposes and are not intended as an accurate location of such obstructions. Obstructions not shown on the Plans but encountered by the Subcontractor shall be removed as necessary and, if directed by the Owner, replaced in their original state or protected by the Subcontractor at no additional cost to the Purchaser.

3.03 REMOVAL OF VEGETATION

A. The rights-of-way/permanent easements shown on the Plans and right-of-way/easement plats shall be cleared of all dead trees, living trees, stumps, brush, projecting roots, hedge, weeds, pole stubs, logs, and other objectionable material, vegetation and growth. This work shall include the removal of all trees, shrubs, and plants not suitable for moving and replanting as determined by the Owner. All trees, stumps, roots, pole stubs, brush, hedge, and other protruding obstructions within the rights-of-way/easements shall be removed to within 3 inches of existing ground. This work shall be done well in advance of excavation operations. Trees and shrubs to be replanted shall be extracted with an ample ball of earth around roots so that transplanting may be successful. The root ball shall be wrapped in burlap. Vegetation stored for replanting shall be watered sufficiently to protect the root system from dehydration.

B. Low hanging branches and unsound branches on trees or shrubs designated to remain, shall be removed. All trimming shall be done by skilled workmen and in accordance with good tree surgery practices.

3.04 REMOVAL OF OBSTRUCTIONS

A. Existing fence material and posts within the rights-of-way/easement limits shown on the Plans and right-of-way/easement plats shall be moved from the construction area and stored in such a manner as to protect them against damage. The Subcontractor shall be responsible for the condition of the removed fence material and posts. The Subcontractor shall demolish and remove all structures and structure foundations within the rights-of-way/easement limits unless otherwise instructed by the Purchaser. Such structures and foundations shall be removed to 12 inches below the subgrade elevation or as directed by the Purchaser. If permitted by the Purchaser, the Subcontractor shall backfill basements, cisterns, and the like in an approved manner. The Subcontractor shall remove all abandoned vehicles, appliances and rubbish within the rights-of-way/easement limits.

3.05 PROTECTION OF OBSTRUCTIONS OUTSIDE RIGHT-OF-WAY/EASEMENT LIMITS

A. The Subcontractor shall protect and avoid damage to all trees, shrubs, plants, fences, turfed areas, structures, and all other objects outside of the right-of-way/easement limits shown on the Plans and right-of-way/easement plats from damage due to construction operations. Damage caused by the Subcontractor shall be repaired or restored at no cost to the Purchaser. Particular care shall be used to avoid damage to trees, shrubs, bushes, turfed areas, and private property located adjacent to rights-of-way/easements on private property. No trees, plants, turfed areas, or other objects outside such limits shall be disturbed or damaged without the written permission of the property owner.

3.06 SPECIAL PROTECTION OF OBSTRUCTIONS INSIDE EASEMENT LIMITS

A. Wherever the underground installation of drainage facilities conflicts with other improvements previously made by the Purchaser, other governmental bodies, or adjacent property owners, the Contractor shall be responsible for their protection and preservation, including necessary removal and storage of such improvements, and subsequent replacement to obtain, to the fullest extent possible, the undisturbed condition.

3.07 DISPOSAL OF DEBRIS

A. All trees, brush, logs, snags, leaves, sawdust, bark, construction debris, and refuse shall be collected and disposed of in accordance with all applicable City codes and ordinances. Debris shall be removed from the site as soon as practical and shall not be left until the completion of the contract. If burning of debris is allowed by the Purchaser, the Subcontractor must obtain and pay for a permit from the City of Memphis Department of Fire Prevention and all precautions necessary shall be exercised to prevent the spread of fire and such burning shall be in accordance with Division 1, “General Requirements” of these Specifications. Burning shall be done only at approved locations and in conformity with the laws, ordinances, and requirements of agencies and officials having jurisdiction. When materials are to be disposed of, the Subcontractor shall obtain written permission before hand from the property owner on whose property the disposal is to be made and shall file a copy of such permit with the Purchaser. Unless otherwise provided in the Contract Documents, the Subcontractor shall make his own arrangements for disposing of such materials off site.

3.08 REPLACEMENT OF VEGETATION

A. As soon as backfill operations permit, the Contractor shall replace transplanted trees, shrubs, and plants. The Contractor shall properly water the transplanted vegetation immediately upon replanting and at suitable intervals thereafter. If shrubs, plants, or trees die after transplanting and before final acceptance of the Work, the Contractor shall at his expensed replace same with equal shrubbery, plants, or trees.

3.09 REPLACEMENT OF FENCES

A. Any fences disturbed within the rights-of-way/easement limits shall be replaced to the satisfaction of the Purchaser. Fences in such poor condition that they cannot be removed and replaced shall be replaced with new fence material similar in original quality, size, and appearance to the removed fence or a written release shall be obtained from the property owners. For chain link fence, new fence materials and construction methods shall conform to the requirements of Specification Section 02820. For box culvert or pipe construction, any fences removed shall be replaced in their original location. Any fence damaged during construction shall be restored to original or better condition. For channel lining construction, removal of fences shall be performed with care and the fence rolled up or stacked and stored on the owner's property. All side yard fences within the easement shall be replaced or extended to the new channel with in-kind fence material.

3.10 ESTABLISHMENT OF TURFED AREAS

A. After final restoration of settled trench surfaces, all areas within the right-of-way or permanent easement limits which were established turfed areas prior to construction will be sodded in accordance with Specification Section 02921. All cut or fill slopes constructed for new drainage facilities will be sodded in accordance with Specification Section 02921 and in conformity with City cross-sections.

3.11 RESTORATION OF OTHER TURFED AREAS

A. All areas outside the right-of-way, permanent easement, or cut and fill slopes shall be restored as nearly as practical to their original condition at the Contractor's expense. Finished lawn areas upon which earth has been deposited shall be cleared to the level of the existing sod and then raked and watered. Areas where sod has been damaged, destroyed, or ruts have been filled in shall be resodded. Areas where sod is only slightly damaged may be lightly reseeded, if so permitted by the Purchaser. Sodding and seeding materials and construction methods shall conform to the requirements of Specification Section 02921.

PART 4 MEASUREMENT & PAYMENT

4.01 MEASUREMENT

A. Site Preparation and Restoration

1. No measurement of area will be made. When changes in the Contract Documents affect the rights-of-way/easement area, a proportionate adjustment for the increased or decreased area will be made.

2. When the Proposal Sheet(s) does not contain an item for Site Preparation and Restoration, this work will be required within the construction limits and will not be paid for directly but will be considered as a subsidiary obligation of the Subcontractor under other contract items.

4.02 PAYMENT

A. Site Preparation and Restoration

1. Payment will be made for Site Preparation and Restoration at the contract lump sum price, which price will be full compensation for removal and/or protection of trees, shrubs, plants, brush, rubbish, fences, man-made obstructions including but not limited to structures,

abandoned appliances, building foundations, and all other obstructions as may directed by the Owner; the disposal of debris and obstructions removed; and the restoration of trees, shrubs, plants, fences; restoration of turfed areas outside of right-of-way, permanent easement and cut and fill slopes, and all other items as shall be specified in the Plans and Contract Documents or directed by the Owner.

4.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02630-4.01.A	SITE PREPARATION AND RESTORATION	LUMP SUM

END OF SECTION 02630

SECTION 02631
EARTHWORK

PART 1 – SCOPE

1.01 This work shall consist of all types of excavation, special protection, protection of existing utilities, backfilling, and grading for all types of drainage facilities including such labor, material and equipment, and all other items as may be necessary to complete the earthwork as shown on the Plans, stipulated in the Contract Documents, or directed by the Purchaser.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIAL

A. Lumber.
Lumber to be used for bracing trenches shall be no less than 2 inch thick rough cut oak.

B. Pit Run Gravel.
Pit run gravel shall consist of one of the three gradations shown in the table below.

1. Total Percent, by Dry Weight, Passing Each Sieve (U.S. Standard)

Size No.	2 ½ "	2"	1 ½ "	1"	3/8"	No. 40	Clay*
1	100	95-100			35-65	10-30	1-12
2		100	95-100		40-65	10-30	1-12
3			100	90-100	45-65	10-35	2-12

* Clay content shall be determined by the Hydrometer Test – AASHTO T 88. Clay content up to 15 percent may be used with the approval of the Purchaser.

2. That portion passing the No. 40 sieve shall be known as the binder. The binder aggregate shall consist of hard durable particles of limestone or a sound silicious material. Shale aggregate or pipe clay binder will not be acceptable, and in no case shall the percent of silt exceed the percent of clay by more than 25 percent.

3. If the binder material is insufficient to properly bond the aggregate, a satisfactory binding material may be incorporated, as approved by the Purchaser, so that the resultant mixture will comply with these Specifications. The mixing shall be done uniformly, and blending of materials on stockpiles or in the pits by bulldozers, clamshells, draglines, or similar equipment will not be permitted.

C. Backfill Material.
Material for backfill shall be fine compactible soil selected from site excavation if approved by the Purchaser as being suitable. Additional material needed shall be obtained from borrow excavation.

2.02 EQUIPMENT
All equipment necessary for the satisfactory performance of this work shall be on the Project and approved before work will be permitted to begin.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 EXCAVATION

A. General.
All excavation performed under this Section including trench excavation, structure excavation, and channel excavation but excluding undercut will be considered unclassified excavation regardless

of the nature of the material and objects excavated and will not be measured or paid for separately except as specifically noted herein. Pavement removal and replacement shall be accomplished as specified in Specification Section 02950.

1. Undercut Excavation.

a. Undercut excavation shall consist of removing and disposing of soft, spongy earth, muck, mud, unconsolidated fill, organic matter, and any other unsatisfactory materials below the grade established on the Plans for storm drains, structures, and channels where determined necessary by the Purchaser. No undercut excavation shall be performed without prior authorization of the Purchaser in writing. The limits of undercut excavation will be determined by the Purchaser, who will be present during the undercut operations.

b. Undercut areas shall be backfilled with suitable material to the grade established on the Plans. The backfill shall be placed in 6 inch maximum lifts and compacted by use of a bulldozer.

2. Unauthorized Excavation Below Subgrade or Outside of Limits.

All unauthorized excavation carried beyond or below the lines and grades given by the Plans or Contract Documents, together with the removal of such excess excavated materials, and the cost of refilling the space of such over dig or unauthorized excavation, shall be at the Contractor's expense. The excess space between the undisturbed bottom and sides of the excavation and subgrade limits shown on the Plans for storm drain pipe shall be refilled with suitable material and compacted per Specification Section 02631, Paragraph 3.01.A.1a unless otherwise directed by the Purchaser. The excess space between the undisturbed bottom of the excavation and subgrade elevations shown on the Plans for box culverts and concrete channel lining shall be refilled with suitable material and compacted per Specification Section 02631, Paragraph 3.01.A.1a. The unauthorized excavation outside of side excavation limits shall be backfilled with select material unless otherwise directed by the Purchaser. The backfill shall be compacted in accordance with Specification Section 02631, Paragraph 3.01.A.1a.

3. Change in Excavation Location or Grade.

If the Purchaser orders in writing that the location or grade of a proposed drainage facility be changed from that shown on the Plans, the following provisions will apply.

a. If the change is made before excavation work has begun and the facility being constructed is covered in the Proposal Sheet(s) by pay items with appropriate depth classifications (pipes, manholes, and similar items), the appropriate pay item will apply to the new depth measurements along the changed centerline. If the changed location or grade introduces a new depth classification not included in the Proposal Sheet(s), a Change Order or Construction Change Order will be prepared in accordance with Specification Section 00710 Article 9 "Changes". If the facility being constructed is not covered in the Proposal Sheet(s) by pay items with depths classifications (box culverts, concrete channel lining, unlined channel, inlets, junction structures, etc.) and if the average depth of excavation per linear foot at the changed location or grade is within 10 percent of the original Plan quantity, there will be no change in the unit price for this work and no additional compensation (or reduced compensation) will be allowed for the change. If the average depth of excavation per linear foot at the changed location is more than 10 percent above or below original Plan quantities, a new unit price for the actual excavation depth will be established. For purposes of comparing changed quantities to Plan quantities, a 1 foot wide strip will be assumed from natural ground line to invert along both the revised and original locations; quantities will then be calculated for the 1 foot wide strip along both conditions and then divided by the proper lengths.

b. If the change is made after excavation has already begun on the original Plan location, the procedures described above will apply to payment for work along the changed location.

If abandonment of an existing excavation or a portion of an existing excavation is required due to a change by the Purchaser, the Contractor will be compensated for the backfilling and restoration of the abandoned excavation. Backfilling and restoration of the abandoned excavation will be accomplished in accordance with the appropriate section of these Specifications.

c. Filling a portion of existing excavation to meet changed grades will be accomplished in accordance with Specification Section 02631 Paragraph 3.01.A.1a.

d. If a change in location and/or grade is authorized in writing by the Purchaser at the written request of the Contractor; whether before or after excavation work has begun; the Contractor will not receive and additional compensation whatsoever for the changed work even though lengths and/or depth of excavation may be greater than original Plan quantities. Backfilling and restoration of abandoned excavation work will be accomplished totally at the Contractor's expense. If changes requested by the Contractor result in reduced lengths and/or depth of excavation, the revised quantities using Proposal unit prices or Change Orders/Construction Change Orders as appropriate will be used to develop payment.

4. Disposition of Excavated Material.

a. Excavated materials suitable for backfill shall be stored no closer than 2 feet from the edge of the excavation to allow free passage of the Purchaser and permit the Purchaser to perform his work in an expeditious and safe manner. Excavated material shall not obstruct crosswalks, sidewalks, street intersections, nor interfere unreasonably with travel on streets by occupants of adjoining property. Gutters or other surface drainage facilities shall not be obstructed. When clear access to fire hydrants, mail boxes, sewer and conduit manholes, and similar utility or municipal service facilities is required, the Contractor must provide such access. Excavated material intended for backfill shall be stored in such a manner as to minimize loss of excavated material due to erosion.

b. All materials excavated, disturbed, damaged, or removed by the Contractor and not to be used for refilling trenches, channels, or structure excavations or to be used in restoration of subsurface or surface facilities or conditions, shall be removed from the site and disposed of by the Contractor, unless otherwise directed. The City reserves the right to retain excess excavation material and direct the Contractor to deliver it to a site specified by the Purchaser at the Contractor's expense. If the Contractor proposes to store or place such excess excavated material upon any property, written consent of the property owner or owners must be secured in advance and a certified copy thereof be filed with the Purchaser. No surplus or excess materials shall be deposited in any stream channel nor in any place where preconstruction surface drainage would be changed, without written permission of the Purchaser.

5. Control of Storm Water.

a. The Contractor shall keep all excavations free of water. He shall provide all dams, flumes, channels, sumps, or other works necessary to keep the excavation entirely clear of water and shall provide and operate pumps or other suitable equipment of adequate capacity for dewatering the excavations. He shall avoid producing mud in the trench or channel bottom by his operations. If necessary or so ordered by the Purchaser, the Contractor shall place pit run gravel at his own expense to maintain a firm, dry excavation bottom and base. Pipe bedding, laying, jointing, and the placing of concrete or masonry shall be done in a water free trench or excavation, which shall be kept clear of water until pipe joints, concrete and masonry have set and are resistant to water damage. The water shall be disposed of at the Contractor's expense.

b. All gutters, pipes, drains, conduits, culverts, catch basins, inlets, ditches, creeks, and other storm water facilities shall be kept in operation, or their flows shall be satisfactorily diverted and provided for during construction. Any facilities disturbed during construction shall be restored to the satisfaction of the Purchaser.

6. Excavation Around Obstructions.

a. The Contractor shall perform all excavation by hand where excavation by machinery would endanger trees, structures, or utilities which otherwise might be saved by the use of hand excavation.

b. The Contractor shall cautiously excavate test holes to locate the limits of underground obstructions anticipated within the excavation. When a water pipe, gas pipe, sewer, or similar utility comes within the limits of the trench, such facilities shall be properly supported.

B. Trench Excavation.

1. All trenches shall be open cut unless otherwise shown on the Plans. Tunneling, boring, or jacking will be allowed only on permission of the Purchaser, unless otherwise shown on the Plans, and a complete record thereof shall be kept in the Contractor's project diary.

2. The Contractor shall be responsible for prosecuting the work in accordance with the grades and lines shown on the Plans or as directed by the Purchaser. Trenches may be excavated by machinery to a depth that will not disturb the finished subgrade. The remaining material shall be hand excavated so that the pipe may be laid on a firm, undisturbed subgrade.

3. No more than 300 feet of trench shall be opened at any time in advance of the completed storm drain, nor shall more than 100 feet be left unfilled except by written permission from the Purchaser. In special cases the Purchaser may limit the distance to which the trench may be opened by notifying the Contractor in writing.

4. The width of trenches below a level 1 foot above the outside top of pipe shall be such as to leave not less than 6 inches on each side of the outside of the pipe for all sizes up to and including 15 inch diameter pipe. Maximum trench width dimension for these pipe sizes shall be 36 inches. For 18 inch diameter pipe, the width of trenches below a level 1 foot above the outside top of pipes shall be such as to allow not less than 6 inches one each side of the pipe, with a maximum trench width of 42 inches. For pipes sizes over 18 inches, the width of trenches below a level 1 foot above the outside top of the pipe shall be such as to allow not less than 12 nor more than 15 inches on each side of the outside top of the pipe. If the trench width at or below that level 1 foot above the outside top of pipe exceeds the widths specified, provision shall be made for the additional load upon the pipe at the Contractor's expense. For pipes other than circular, trench width shall be adjusted to provide for the additional pipe width along the along the horizontal axis.

5. The sides of the trench shall be as nearly vertical as possible. The bottom of the trench shall be carefully graded, formed, and aligned according to the Plans and to the satisfaction of the Purchaser before storm drains are laid thereon.

6. The bottom of the trench shall be excavated at each joint of bell and spigot pipe to allow the body of the pipe a uniform contact and support throughout its entire length. When mortar joints are specified, bell holes shall be excavated at each joint in the pipe line to provide space underneath the pipe in which to properly build up mortar joints.

C. Excavation for Drainage Structures.

1. The Contractor shall be responsible for prosecuting the Work in accordance with the lines and elevations shown on the Plans or as directed by the Purchaser. The Contractor shall excavate as required for all structures with foundations carried to firm, undisturbed earth at the elevation of the underside of the structure.

2. The outside dimensions of all manholes, inlets, box culverts, channel lining, and other drainage structure excavations shall be at least 12 inches greater than the outside of the masonry or concrete work to permit backfilling around structure.

3. Where structures are to be built in street right-of-way or paved areas, the excavation shall not exceed 2 feet from the outside of the masonry or concrete work. In the event that the excavation exceeds this limit, the Contractor will be required, at his expense, to backfill the entire space around the structure with suitable material compacted as specified in Specification Section 02631 Paragraph 4.0.

4. For drainage facilities to be constructed in fill areas, the fill shall first be placed and compacted in accordance with these Specifications. The excavation for the drainage facilities shall then commence following the placement of fill.

D. Unlined Channel Excavation.

The Contractor shall be responsible for prosecuting the Work in accordance with the grades and lines shown on the Plans or as directed by the Purchaser. The sides and bottom of the channel shall be excavated and shaped so as to conform with the cross-sections shown on the Plans or as directed by the Purchaser.

3.02 SPECIAL PROTECTION

A. Treacherous Ground.

When running sand, quicksand, or other treacherous ground is encountered, the work shall be carried on with the utmost vigor and shall be prosecuted day and night should the Purchaser so direct.

B. Sheeting and Shoring.

1. The Contractor shall furnish, place, and maintain such sheeting and shoring as may be required to support the sides of any excavation to prevent earth movement that could endanger the work or workmen; or to prevent any earth movement which might in any way delay the Work, change the required width of the excavation, or endanger adjacent pavement, utilities, sewers, buildings, or other structures above or below the ground surface; or to contain the construction within a specified area such as an easement or street right-of-way. The Contractor shall place this sheeting and shoring for such protective purposes without the Purchaser's instructions.

2. During the extraction of sheeting, care shall be exercised to prevent damage due to settlement or movement of new drainage facilities. The sheeted trench width, as measured between those faces of the sheeting in contact with the earth trench wall, shall not exceed the maximum width of trench specified in Specification Section 02631 paragraph 3.01.B. below an elevation 1 foot above the top of the pipe. Walers and struts shall be designed and installed to present no obstructions to proper placement of the pipe, bedding, cradle or encasement, nor shall they interfere with the satisfactory laying and jointing of the pipe.

3. Sheeting, bracing, and shoring shall be withdrawn and removed as the backfilling is being done, except where and to such extent as the Purchaser shall order that sheeting, bracing, and shoring be left in place, or where the Purchaser will permit the same to be left in place at the

Contractor's request. The Contractor shall cut off any such sheeting at least 2 feet below the surface and shall remove the cutoff material from the excavation.

4. All sheeting, bracing, and shoring which is not left in place under the foregoing provisions shall be removed in a manner which will not endanger the completed work or other structures, utilities, sewers, or property whether public or private. The Contractor shall exercise care to prevent the opening of voids during the extraction process.

5. Steel drag shields or trench boxes may be used in lieu of sheeting, shoring, and bracing unless the Purchaser directs otherwise.

C. Excess Width of Trench.

If the Contractor is permitted to use equipment that results in wider trenches than hereinbefore specified, concrete cradle or additional concrete cradle shall be used around pipe if required to resist the additional load caused by the extra width. The dimensions of this cradle will be specified by the Purchaser, and no extra compensation will be allowed for the additional material or work.

D. Blasting.

1. Blasting shall be under taken only after the Contractor has received written authorization from the Purchaser. With respect to the use of explosives in blasting, the Contractor shall apply for and receive all necessary permits and comply with all federal and state laws, rules, ordinances and regulations and requirements of the insurer governing the keeping, storage, use, manufacture, sale, handling, transportation, or other disposition of explosives. The Contractor shall provide additional liability insurance to the City, with limits and coverages as specified by the Purchaser, covering blasting operations in advance of any blasting. All operations involving the handling, storage, and use of explosives shall be conducted with every precaution under the supervision of a properly licensed individual. The Contractor shall take special precautions for the proper use of explosives both at or near the top of the excavation and in the excavation in order to prevent harm to human life and damage to surface structures, utilities, sewers, or other subsurface structures. The Contractor shall advise the Purchaser in advance when charges are to be set off. Blasts shall not be fired until all persons in the vicinity have had ample notice and have reached positions of safety.

2. Storm drains shall be carefully protected from all blasts, and all excavations requiring blasting shall be fully completed at least 30 feet in advance of the laying of the pipe. In all cases, the mouth of the pipe shall be provided with a board or other stopper carefully fitted to the pipe to prevent all earth or other substances from entering.

3. After a blast is fired, the Contractor shall thoroughly scale the excavation. All loose shattered rock or other loose material which may be dangerous to the workmen, pipe, or structure shall be removed and the excavation made safe before proceeding with the Work. The fact that the removal of loose, shattered rock or other loose material may enlarge the excavation beyond the required width will not relieve the Contractor from making such removal and filling the extra space. The Contractor shall not be entitled to extra compensation therefore.

E. Wellpoints.

The Contractor shall use wellpoints, sump pumps, or any other method of dewatering as required to lower the water table below the bottom of the excavation. He shall make a request to the Purchaser and receive approval of the use of special dewatering equipment other than well points or sum pumps. Dewatering operations are considered incidental to the Work and no additional compensation shall be made to the Contractor.

F. Underpinning.

When excavations require underpinning of existing structures, the Contractor shall submit shop drawings of underpinning details to the Purchaser prior to commencement of excavation below the

foundation of the structure. Review of underpinning details by the Purchaser shall not relieve the Contractor of his responsibility for protection of the structure and its contents.

3.03 EXISTING UTILITIES

A. Location.

The Plans indicate the available records of location of existing structures and facilities, both above and below the ground, but the City assumes no responsibility for the accuracy or completeness of this information. Utility service connections are not shown on the Plans, but can be encountered at any location on the Project. If it is necessary to adjust or relocate any utility, it shall be the Contractor's responsibility to coordinate the work with the appropriate utility. Any cost or delays incurred by the Contractor in this activity shall be incidental and no additional compensation will be made.

B. Protection.

1. If the construction of the storm drains, structures, or channel requires the removal and replacement or protection of any overhead wires or poles, the Contractor shall make satisfactory arrangements for such work with the owner or owners of such wires and poles and no additional payment will be made by the City.

2. The Contractor shall protect any sewer or utility within the limits of the construction. The Contractor shall proceed with caution in any excavation and shall use every means to determine the exact location of underground structures, pipe lines, conduits, and similar obstructions prior to excavation in the vicinity thereof. The City will not be responsible for the cost of protection or repair or replacement of any structure, pipe line, conduit, service connection, or similar facility above and below ground which may be broken or otherwise damaged by the Contractor's operations. All water and gas pipes and other conduits adjacent to or crossing the excavation shall be properly supported and protected by the Contractor.

C. Service Connections.

1. Sewer and utility services between mains and buildings shall be maintained and adjusted as necessary by the Contractor so as to provide as nearly a continuous operation as reasonably can be expected. This shall be accomplished in any way that the Contractor may desire, provided that the individual service not be inoperative more than two consecutive hours. The occupants shall be notified by the Contractor at least six hours in advance of such service interruptions. When a break occurs, the Contractor shall notify the affected occupant(s) of the probable length of time that the service will be interrupted.

2. If existing underground facilities or utilities require removal and replacement for the prosecution of this Work, all replacements of such underground construction or parts thereof shall be made with new materials conforming to the requirements of these Specifications or, if not specified, as approved by the Purchaser.

3. The removal and replacement of water services to accommodate new construction shall be the Contractor's responsibility within the limits where the new service line grade blends smoothly with the existing service line grade. This work will be incidental to the construction of the drainage facility and no additional compensation will be made.

4. The removal and replacement of sewer services to accommodate new construction shall be the Contractor's responsibility from the sewer main to a point where the new grade and existing grade can be matched. Payment will be made in accordance with Specification Section 02631 Paragraph 5.05.

5. The Contractor shall be responsible for any damage to the service as a result of his operations. The City does not guarantee the number, size, condition, nor length of adjustment necessary to bring a service to a new grade.

3.04 BACKFILLING

A. General.

1. Bedding for drainage facilities shall be constructed in accordance with the following specifications for the various type facilities:

a. Storm Drain Pipe: Specification Section 02632 Paragraph 3.02.B
b. Manholes, Inlets and Special Structures: Specification Section 02640 Paragraph 3.02
c. Reinforced Concrete Box Culverts: Specification Section 02641 Paragraphs 3.02.B and 3.01.B

After drainage facilities have been bedded and installed in accordance with appropriate specifications and upon permission of the Purchaser, the backfill may be placed. No trash will be allowed to accumulate in the space to be backfilled. Particular care shall be taken to avoid allowing wood to be included in the backfill, other than sheeting and shoring that has been approved to be left in place.

2. The Contractor shall at all times be responsible for the condition of the trenches and filled areas. He shall maintain frequent inspection of same and at any time before the final acceptance of the work by the City the trenches or filled areas settle and sunken places appear, he shall be required to refill these sunken places with suitable material as soon as they are discovered. All trenches shall be barricaded and caution lighted at all times for the protection of the public.

3. Backfilling shall be accomplished as soon as practicable after underground work is completed and inspected. Backfilling operations shall proceed in an orderly fashion following as closely behind construction operations as practical.

4. All backfill shall be placed in uniform horizontal layer. “Ramping,” that is pushing backfill material down a ramp into excavated areas, will not be permitted unless authorized in writing by the Purchaser.

B. Backfill in Street Right-Of-Way and Improved Property

1. Backfill Material in Pavement Areas.

Backfill in excavations through pavement in street right-of-way or wherever prevention of backfill settlement is considered essential such as driveways and paved parking areas on private property, and where the Plans require or the Purchaser orders, shall be made with pit run gravel or other acceptable material from the top of the bedding material or foundation to the subgrade elevation of the pavement. Pea gravel, sand or similar granular materials approximately uniform in size and without bonding properties shall not be used.

2. Backfill Material Outside of Pavement Areas.

a. Backfill in excavations outside of pavement in street right-of-way or outside of public right-of-way shall be made with select, job-excavated earth from the top level of the bedding material or foundation to the subgrade elevation in paved area, or to within 1 inch of the surface in areas to be sodded, or to the surface in all other areas.

b. Nongranular, job-excavated material shall be free from debris, organic matter, perishable compressible materials, and shall contain no stones or lumps or rock fragments larger than 6 inches in dimension, nor be in such amount that will interfere with the consolidating properties of the fill material. Care shall be taken that stones and lumps are

kept separated and will distributed, and that all voids are completely filled with fine materials. The upper 3 feet of backfill in sodded or planted areas shall be free of such rocks or lumps larger than 1 inch in diameter.

3. Placement and Compaction.

a. Storm Drain Trenches.
As soon as the pipe has been bedded, laid, jointed, and inspected by the Purchaser, backfilling shall continue in the following manner. Backfill shall be placed by hand in 6 inch loose layers above the bedding and tamped with heavy tampers or pneumatic tampers, special care being taken not to damage the pipe or joints, to a point 2 feet above the outside top of the pipe. From this point to the subgrade elevation of the pavement, or to the bottom of the sod, or to the original ground surface in all other areas, suitable backfill shall be placed in 12 inch loose layers and compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698).

b. Structure and Box Culvert Excavations.
As soon as the masonry or concrete work has set sufficiently to withstand compaction, and the Purchaser has inspected it, suitable backfill shall be placed in 6 inch loose layers concurrently and uniformly on all sides and compacted with heavy tampers or pneumatic tampers to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698). Suitable backfill shall be placed in this manner concurrently on all sides from the foundation of the structure or culvert to the subgrade elevation of the pavement, or to the bottom of the sod or to the original ground surface in all other areas.

c. Concrete Channel Lining Excavations.
As soon as concrete work has set sufficiently to withstand backfilling and has been inspected by the Purchaser, select backfill material shall be placed by methods other than ramping and compacted by jetting or flooding from the foundation of the channel lining to 3 inches above the top of the wall. Backfill will be rounded slightly adjacent to the top of wall to an elevation 1 inch above the top of the wall to assure positive surface drainage over the top of the wall. Backfill operations shall be coordinated with placement of the weep hole drainage system behind the channel lining wall. Special care shall be exercised during backfilling operations to prevent settlement behind channel lining walls.

C. Backfill in Open Areas and Unimproved Property

1. Backfill Material. Backfill for storm drain pipe excavations in open areas and unimproved property shall be made with select earth material from the top level of the bedding material or foundation to the surface. Backfilling for structures, box culverts, and concrete channel lining excavations in open areas and unimproved property shall be performed in accordance with Specification Section 02631 Paragraph 3.04.B. Nongranular, job-excavated material to be used for backfill shall be free from debris, organic matter and perishable compressible materials, and shall contain no stones or lumps or rock fragments larger than 6 inches in dimension or in such amount that will interfere with the consolidating properties of the fill material. Stones and lumps shall be kept separated and well distributed, and all voids shall be completely filled with fine materials.

2. Placement of Backfill. Backfill procedures specified for improved areas shall apply from the trench bottom to a point 2 feet above the outside of the pipe. From this point to slightly above the surrounding surface elevation, suitable backfill may be placed by bulldozer or other mechanical means.

D. Drainage Facilities Placed on Fill

1. Fill material placed in areas over which drainage facilities will be constructed shall be select earth material from the elevation of suitable subgrade to the bottom elevation for bedding or foundation of the drainage facility.

2. Placement and Compaction. If drainage facilities are constructed on filled areas, the fill material shall be placed in 6 inch loose layers and compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698) up to a point at least 2 feet above the outside top of the pipe or to the foundation of manholes, inlets, special structures, box culverts, concrete channel lining and concrete ditch paving. If compaction standards for storm drain pipe exceed that of the adjoining fill, the width of compaction for the storm drain shall be not less than the outside diameter of pipe plus 10 feet. If compaction standards for the manhole, inlets, special structure, box culverts, concrete channel lining and concrete ditch paving exceed that of adjoining fill, the limits of compaction for the facility shall be not less than 5 feet outside of the facility base slab.

3.05 FINAL GRADING

A. Final grading around and above drainage facilities shall be shaped to the slope of adjacent undisturbed ground. Sufficient grading operations shall be performed to provide natural surface drainage from adjacent properties into drainage facilities.

B. Grading above the top of concrete channel lining walls shall be accomplished in accordance with proposed cross-sections supplied by the City at the preconstruction conference or as directed by the Purchaser. Grading shall provide adequate drainage over the top of channel walls. Side slopes shall be graded to provide a minimum slope of ½ inch per foot beginning 3 inches above the top of channel walls. Side slopes shall be rounded off near the channel wall to an elevation of 1 inch above the top of wall. The addition of sod will provide a final side slope elevation 2 inches above the top of wall.

PART 4 – MEASUREMENT

4.01 UNDERCUT BACKFILL
Undercut backfill will be measured by the ton of suitable material.

4.02 SHEETING AND SHORING DIRECTED TO REMAIN IN PLACE
Sheeting and shoring directed to remain in place will be measured by the 1,000 board feet, in place prior to being cut off below grade. Sheeting and shoring placed and removed by the Contractor will not be measured for payment.

4.03 PAVEMENT BACKFILL
Pit run gravel or other suitable materials used for backfill as determined by Specification Section 02631 Paragraph 3.04.B will be measured by the ton and will be paid for at the contract unit price per ton furnished and placed, which price will be full compensation for furnishing, placing and compacting the selected fill.

4.04 UNLINED CHANNEL
Unlined channel will be measured per linear foot along the centerline for various channel cross-sections, complete in place.

4.05 SEWER BUILDING (HOUSE) CONNECTION REMOVAL AND REPLACEMENT
Sewer building connection removal and replacement for construction of drainage facilities shall be measured per each, complete in place. Sewer building connections damaged by the Contractor which do not require removal and replacement for construction of drainage facilities will not be measured for payment.

4.06 GENERAL
All work for excavation, blasting, drainage of trench and dewatering, backfilling of excavation, compaction, grading, protection of existing utilities, water service connection adjustments, disposal of excess materials, and all other similar items included in this section of the Specifications but not covered by a Pay Item herein will be considered as a subsidiary obligation of the Contractor under other Pay Items of the Contract.

4.07 COMPACTION TESTING
Soil test as required by the Purchaser will be paid for by the test as performed by a testing agency which meets the approval of the Purchaser.

PART 5 – PAYMENT

5.01 UNDERCUT BACKFILL
Accepted quantities of undercut backfill will be paid for at the contract unit price per ton of backfill material furnished and placed, which price will be full compensation for undercut excavation, special protection, protection of existing utilities, and backfilling to bottom of facility subgrade elevations, complete in place.

5.02 SHEETING AND SHORING DIRECTED TO REMAIN IN PLACE
Accepted quantities of sheeting and shoring directed by the Purchaser to remain in place will be paid for at the contract unit price per 1,000 board feet in place prior to being cut off below grade, which will be full compensation for material only. The cost of placing sheeting and shoring to remain in place shall be incidental to the work. No payment will be made for sheeting and shoring placed and removed by the Contractor.

5.03 COMPACTION TESTING
Accepted quantities of compaction tests as required by the Purchaser will be paid for at the contract unit price per test.

5.04 UNLINED CHANNEL
Accepted quantities of unlined channel will be paid for at the contract unit price per linear foot for various channel cross-sections, which price will be full compensation for excavation, removal, and disposal of excavated material and grading, complete in place.

5.05 SEWER BUILDING (HOUSE) CONNECTION REMOVAL AND REPLACEMENT
Accepted quantities of sanitary sewer building connections removed and replaced will be paid for at the contract unit price per each connection, which price will be full compensation for excavation, removal of old connection line and appurtenances, materials and construction of new connection, joining to existing connection line, and backfilling, complete in place.

5.06 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02631-01	Undercut Backfill	Ton
02631-02	Sheeting and Shoring Directed to Remain In Place	1,000 Board Feet
02631-03	Soil Compaction Test	Each
02631-04	Unlined Channel	Linear Foot
02631-04.	Description	Linear Foot
02631-05	Sewer Building (House) Connection	Each
02631-06	Removal and Replacement Pavement Backfill	Ton

END OF SECTION 02631

SECTION 02820
CHAIN LINK FENCE

PART 1 GENERAL

1.01 SCOPE

A. This work shall consist of the construction of chain link fences and gates in accordance with these Specifications and at the locations and in conformity with the lines, grades, and dimensions shown on the Plans or as directed by the Owner. Chain link fence may be located atop concrete channel lining walls, retaining wall or similar structure, or may be located independently of structures.

PART 2 PRODUCTS

2.01 MATERIALS.

A. Materials used throughout the project shall be of constant design and manufacture in respect to individual items or parts, excepting where the proposed fence will be an extension of an existing fence, in which case the new fence shall be constructed of materials similar in appearance to those in the existing fence and continued until broken by cross street, railroad, fence ditch, or other physical feature. Unless otherwise directed, new materials shall be as described hereinafter.

B. Fabric.

1. The fabric shall be zinc coated steel chain link type meeting the requirements of AASHTO M 181 for Type I, Class B fabric (zinc coating = 2 oz/ft^2). All chain link fabric shall be manufactured of No. 9 gauge wire pickets, forming a uniform 2 inch mesh, and shall be of the height shown on the Plans or specified in the Contract Documents. Fabric up to and including 60 inches high shall be knuckled at the top and bottom selvage and fabric over 60 inches high shall be twisted on the top selvage and knuckled on the bottom selvage.

C. Line Posts.

1. Line posts shall be zinc coated steel pipe or H-sections of the following dimensions and of the lengths shown on the Plans or specified herein:

		H - Section			
Fence Height (pounds)	Nominal Size (inch)	Outside Diameter (inch)	Weight Per Foot (Pounds)	Dimension (inches)	Weight Per Foot
6 feet or less	1 ½	1.9	2.72	1.875 x 1.625	2.70
6 feet to 8 feet	2	2.375	3.65	2.25 x 1.95	4.10

2. Steel pipe shall conform to ASTM A 120 or AASHTO M181-85I Grade 2 and H-Sections shall be produced from ASTM A 570 and ASTM A 572, Grade 45. The weight of zinc coating shall be a minimum of 1.8 oz/square foot. The weight of zinc coating and weight per foot for steel post meeting the requirements of AASHTO M181-85I grade 2 may vary from the above noted valves.

D. End Posts, Corner And Pull Posts, And Braces.

E. End posts, corner posts, and pull posts shall be zinc coated steel pipe or square sections of the following dimensions and of the lengths shown on the Plans or specified herein:

	Steel Pipe			Square Section	
Fence Height (pounds)	Nominal Size (inch)	Outside Diameter (inch)	Weight Per Foot (Pounds)	Outside Dimension (inches)	Weight Per Foot
6 feet or less	2	2.375	3.65	2.0	3.60
6 feet to 8 feet	2 ½	2.875	5.79	2.5	5.70

1. Diagonal braces shall be 1 ¼ inch (1.660 inch O.D.) galvanized steel pipe, weighing 2.27 pounds per foot. Steel pipe and square sections shall conform to ASTM A 120 or AASHTO M181-85I Grade 2. The weight of zinc coating and weight of pipe per foot for steel post meeting the requirements of the AASHTO M181-85I grade 2 may vary from the above noted valves.

F. Top Rail:

1. Top rail shall be used when specified on the Plans in lieu of top tension wire. The top rail shall be 1 ¼ inch (1.660 inch O.D.) galvanized steel pipe, weighing 2.27 pounds per foot, meeting the requirements of ASTM A 120 or AASHTO M181-85I Grade 2. Top rails in random lengths shall be fitted with expansion sleeves for connecting lengths into a continuous run or shall have a 3 inch swagged end. Suitable fittings shall be provided for securing top rail to each gate, corner, and end post.

G. Barbed Wire:

1. Barbed wire shall consist of two No. 12 ½ gauge, twisted steel strands with No. 14 gauge four-point barbs spaced not more than 5 inches apart. The galvanized strands shall meet the requirements of ASTM A 121, Class II coating.

H. Miscellaneous Fittings And Hardware:

1. Zinc coated miscellaneous fittings and hardware shall be commercial grade steel or better quality, pressed, wrought, or cast as appropriate to the article, and sufficient in strength to provide a balanced design when used in conjunction with fabric, posts, and wires of the quality specified herein. All steel fittings and hardware shall be galvanized in accordance with AASHTO M 111.

I. Barbed Wire Support Arms:

1. Barbed wire support arms shall be single arms for carrying 3 barbed wire strands. Barbed wire support arms for line posts shall be at an angle of 45 degrees (plus or minus 5 degrees) and shall be fitted with clips or other suitable means for attaching three lines of barbed wire, with the top strand of barbed wire 12 inches (plus or minus 1 inch) above and horizontally from the fence line, and the remaining two strands of barbed wire spaced uniformly between the top of the fence fabric and top strand of barbed wire. Support arms shall be capable of withstanding a load of 250 pounds when the base is clamped securely

and the vertical load applied from where the outer strand of barbed wire passes over the arm.

J. Wire Ties:

1. Wire ties shall be No. 9 gauge and shall be either zinc coated steel, aluminum coated steel or aluminum alloy and sufficient in strength and other properties to provide a balanced design when used in conjunction with fabric, posts, and wire of the qualities specified herein. When tension wire is used, wire ties and clips for fastening fabric to tension wire shall be No. 11 gauge.

K. Tension Wire:

1. Tension wire shall be used at the bottom of fencing fabric when not otherwise secured and used at the top unless a top rail is specified. Tension wire shall be No. 6 gauge, spring rolled, aluminized steel wire.

L. Truss Rods and Turnbuckle:

1. Truss rods shall be 3/8 inch diameter steel rods and shall be equipped with a turnbuckle having a take-up of not less than four inches and shall be galvanized in accordance with AASHTO M 111.

M. Fence Gates:

1. Fence gates shall be of the kinds and sizes shown on the Plans or specified in the Contract Documents. They shall be of the swing type, complete with latches, stops, keepers, hinges, and fabric. The latch shall have provision for fastening with a padlock. The gates shall be covered with fabric matching the fence. The hinges shall be of adequate strength to support the gate and shall not twist or turn under action of the gate. The gates, gate posts, and braces shall be of the same material and finish as the adjoining fence. All gate posts and rails shall be furnished complete with ball caps and rail ends.

2. Posts, braces, and framing members for chain link fence gates shall be zinc coated steel pipe meeting the requirements of Specification Section 02820 Paragraph 2.01.C. Gate post shall be 2 ½ inch (2.875 inch O.D.) pipe weighing 5.79 pounds per foot for gate widths of 5 feet or less; and 3 ½ inch (4.0 inch O.D.) pipe weighing 9.10 pounds per foot for gate widths between 5 feet and 13 feet.

3. Framing members and interior bracing shall be of the following minimum dimensions:

Framing and Bracing

Fence Height	Nominal Size	Outside Diameter	Weight Per Foot
6 feet or less	1 ¼	1.66	2.27
6 feet to 8 feet	1 ½	1.90	2.72

a. Gate frames shall be welded at all corners or assembled with corner fittings. When corner fittings are used, gates shall have truss rods as specified in Specification Section 02820 Paragraph 2.01.J to prevent sag or twist. All welded joints shall receive a shop applied zinc coating equivalent in thickness to that of the members being joined.

4. Fabric shall meet the requirements of Specification Section 02820 Paragraph 2.01.A.

5. Barbed wire shall meet the requirements of Specification Section 02820 Paragraph 2.01.E.

6. Miscellaneous fittings and accessories shall meet the applicable requirements of Specification Section 02820 Paragraphs 2.01 F, G, H, and J. The hinges shall be of such design to allow the gate to swing back 180 degrees, parallel with the fence line.

N. Concrete.

1. Concrete for post footings shall be Class A as specified in Specification Section 03050.

O. General.

1. Posts shall be fitted with ornamental tops or extension arms as stipulated in the Plans or in the Contract Documents. Caps or ornamental tops for tubular posts shall have a base fitting into the post with a flange extending over the top of the posts to protect against moisture. When a top rail is provided, all posts shall be provided with caps having a ring or hole suitable for the through passage of the top rail. Rail and brace ends, or other suitable means of connection, shall be provided when top rail or braces are required.

2. Fabrication of all materials shall be in conformity to the sizes, shapes, and other factors set out in these Specifications or shown on the Plans, and shall show careful, finished craftsmanship in all respects.

3. The weights specified for steel posts, braces, and rails are nominal weights, and a plus or minus tolerance of 5 percent will be permitted. All posts located on the top of concrete channel lining walls or similar structure shall be of sufficient length to be set fully 12 inches into the wall or structure.

4. All line posts located on the ground shall be of sufficient length to be set fully 24 inches deep into concrete footings, and all end, corner, and pull posts shall be of sufficient length to be set 30 inches deep into concrete footings.

2.02 EQUIPMENT

A. All equipment necessary for the satisfactory performance of the work shall be on hand and inspected by the Owner before construction work will be permitted to begin.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS.

A. Fencing shall be placed atop concrete structures, such as concrete channel linings, in accordance with Plans and Design Standards. Fence post inserts will normally have been set into the concrete walls prior to fence construction activities. Inserts shall be 12 inch ling solid wall PVC pipe conforming to ASTM D2241, thin wall metal conduit conforming to ANSI C 80.3 and sealed at one end or other material approved by the Owner. Cans, bottles and the like shall not be used as inserts. Alternatively, posts may be sect directly into the structure concrete as the concrete is poured, making sure that all posts are plumbed and held securely in the proper position until the concrete has set.

B. The inside diameter of the inserts shall be sufficient to provide a minimum of ¼ inch clear space between the outside surface of the post and the inside surface of the insert. Inside of inserts shall be cleaned of debris and other foreign matter, insert space filled full of non-shrinking grout,

the posts set into place in the insert and plumbed, and the post held plumb until the grout has set. All excess grout shall be removed before it sets. Where inserts have not been provided in the concrete structure, post holes of the same diameter and depth as required for inserts shall be cored in the concrete. Posts shall be set in cored holes in the same manner as posts set in inserts.

3.02 FENCING SET INDEPENDENTLY OF STRUCTURES.

A. Before beginning construction or placing of fences, all necessary work for clearing and grubbing, removal of structures and obstructions, and site preparation shall be performed in accordance with the applicable Sections of these Specifications. Clearing for fence construction shall not extend beyond the construction easements without written approval of the property owner. Living trees and shrubs one foot or more each side of the fence line shall remain undisturbed unless otherwise directed by the Owner. Any rock protruding above the ground surface and in the line of the fence shall be removed to ground surface.

B. Posts for chain link fence shall be set at intervals not to exceed 10 feet. The interval between posts shall be measured parallel to the bottom of the fabric of the proposed fence and in line of fence from center to center of post.

C. All line posts located on the ground shall be set fully 24 inches deep in concrete footings; end, corner and pull post shall be set 30 inches deep in concrete footings. Diameters of footing shall be : for line post not less than 8 inches; for end, corner or pull post not less than 10 inches. Footings for gate post shall be designed to support the cantilever load of the gate. Concrete for embedment of posts and for anchors shall be Class A and shall be crowned to shed water. Concrete shall be cured a minimum of 3 days prior to installation of fabric.

3.03 ERECTING FENCE.

A. For fence heights less than 6 feet a top and bottom tension wire shall be installed, unless specified otherwise. For fence heights 6 feet or greater a top rail and bottom tension wire shall be installed. When a top rail is specified, the top rail shall be connected with expansion sleeves to form a continuous rail.

B. Bracing assemblies consisting of the specified bracing pipe as the compression member and specified truss rod as the tension member shall be installed and securely tightened prior to installation of fabric. One brace assembly shall be provided for end post and two brace assemblies for corner and pull posts. When fence alignment changes abruptly by more than 30^0 a corner brace assembly shall be installed. When the internal angle of a curved fence alignment exceeds 30^0 one brace assembly shall be installed at each point of curvature. Pull post shall be installed at abrupt changes in grade or at the midpoint of a straight fence alignment exceeding 500 feet in length.

C. The fabric shall be placed on the side of the post as directed by the Owner and 2” above ground or concrete structure. Fabric shall be secured at one end and sufficient tension applied to remove all slack before making attachment elsewhere. The fabric shall be fastened to the posts with wire ties at intervals not exceeding 14 inches. Fabric shall be fastened to the tension sire or rail with wire ties at intervals not exceeding 24 inches. When specified, barbed wire shall be installed and pulled taut before being permanently attached to a post or arm. Fence gates shall be constructed in accordance with the Plans, Specifications and manufacturer’s standards and instructions, or as directed by the Owner.

3.04 TEST

A. Before any fencing is installed, manufacturer’s certificates stating that the fabric, post, rails, braces, barbed wire, tension wire, ties and hardware are made in accordance with applicable

standards as specified herein shall be filed with the Owner. At the option of the Owner, test samples of any materials to be furnished shall be furnished at the job site before work commences.

PART 4 PAYMENT

4.01 MEASUREMENT

A. Chain Link Fence

1. Fences will be measured for payment by the linear foot along the bottom of the fabric and from end to end of fence, complete and in place, deducting the width of gates and openings, for each type and height of fence provided.

B. Fence Gates

1. Gates will be measured for payment by the unit, per each, complete and in place, for the kinds and dimensions as shown on the Plans.

4.02 PAYMENT

A. Chain Link Fence

1. The accepted quantities of chain link fence will be paid for at the contract unit price per linear foot, complete and in place, for each type and height of fence, which price will be full compensation for fabric, posts, rails, tension wire, miscellaneous hardware, post hole excavation, concrete footings, concrete coring and grouting.

B. Fence Gates

1. The accepted quantities of gates will be paid for at the contract unit price per each, complete and in place, for the kinds and dimensions of gates stipulated or shown on the Plans.

4.03 Payment will be made under:

Item No.	Pay Item	Pay Unit
02820-4.01.A	CHAIN LINK FENCE HEIGHT x DESCRIPTION	LINEAR FOOT
02820-4.01.B	FENCE GATES HEIGHT x WIDTH OF OPENING	EACH

END OF SECTION 02820

SECTION 02920
SEEDING

PART 1 - SCOPE

This work shall consist of furnishing and placing seed, commercial fertilizer, agricultural limestone, erosion control fabric, and mulch material when specified, and of caring for such areas until acceptance, all in accordance with these Specifications, on all newly graded earthen areas that are not to be paved, stabilized, or sodded, unless otherwise indicated on the plans or directed by the Purchaser.

PART 2 - MATERIALS AND EQUIPMENT

2.01 MATERIALS.

A. Grass Seed.

1. The seed shall meet the requirements of the Tennessee Department of Agriculture and no "Below Standard" seed will be accepted. Grass seed furnished under these Specifications shall be packed in new bags or bags that are sound and not mended.

2. The Contractor shall furnish the Purchaser a certified laboratory report from an accredited commercial seed laboratory or from a State seed laboratory showing the analysis of the seed to be furnished and approving the seed for purity and germination. The report from an accredited commercial seed laboratory shall be signed by a Senior Member of the Society of Commercial Seed Technologists. At the discretion of the Purchaser, samples of the seed may be taken for a check against the certified laboratory report. Sampling and testing will be in accordance with the requirements of the Tennessee Department of Agriculture.

3. When a seed group is used, the percentages forming the group shall be as set out below, unless otherwise specified.

Name	Quantity, Percent by Weight
Group A	
Lespedeza (Common or Korean)	20
Sericea Lespedeza	15
Ky. 31 Fescue	40
English Rye	15
White Dutch Clover	5
Weeping Love Grass	5
Group B	
Ky. 31 Fescue	55
Redtop	15
English Rye	20
White Dutch Clover	5
Weeping Love Grass	5
Group C	
Sericea Lespedeza	50
Ky. 31 Fescue	30
English Rye	15
White Dutch Clover	5

4. In mixing or forming “Groups” of seed, they shall be uniformly mixed. “Group” seed shall not be mixed until after each type seed that is used to form the “Group” has been tested and inspected separately and approved for purity and germination. Seed mixed before tests and inspection are made will not be accepted.

B. Fertilizer.

Manufactured fertilizer shall be a standard commercial fertilizer containing the specified percentages by weight of nitrogen (N), phosphoric acid (P_2O_5) and potash (K_2O). The fertilizer shall be furnished in standard containers with the name, weight, and guaranteed analysis of the contents clearly marked. The containers shall insure proper protection in handling and transporting the fertilizer. All commercial fertilizer shall comply with local, state, and federal fertilizer laws.

C. Agricultural Limestone.

Agricultural limestone shall contain not less than eighty-five (85%) of calcium carbonate and magnesium carbonate combined and shall be crushed so that at least 85 percent will pass the No. 10 mesh sieve and 100 percent will pass the 3/8 inch sieve.

D. Mulch Material.

All mulch material shall be air dried and virtually free of noxious weeds and weed seeds or other materials detrimental to plant growth on the work site or on adjacent agricultural lands. Hay shall be stalks of approved grasses, sedges, or legumes seasoned before baling or loading. Straw shall be stalks of rye, oats, wheat, or other approved grain crops. Both hay and straw shall be suitable for spreading with standard mulch blower equipment. Biodegradable fabric as specified in this section may be used as an alternate to mulch material at the Contractor’s option.

E. Inoculants for Legumes.

Inoculants for treating legume seed shall be standard cultures of nitrogen fixing bacteria that are adapted to the particular kind of seed to be treated. The inoculant shall be supplied in convenient containers of a size sufficient to treat the amount of seed to be planted. The label on the container shall indicate the specified legume seed to be inoculated and the date period to be used.

F. Mulch Binder.

Cut back asphalt, Grade RC-70 or RC-250 conforming to AASHTO Specifications shall be used.

G. Water.

Water shall be free from any harmful or objectionable qualities or organisms.

H. Biodegradable Fabric.

1. Biodegradable fabric shall consist of a knitted or bonded construction of yarn with uniform openings interwoven with strips of biodegradable paper. The fabric shall be degradable by exposure to ultraviolet light. The fabric shall be “Hold/Gro” as manufactured by Gulf States Paper Corporation of Tuscaloosa, Alabama, or equal. The fabric shall be furnished in rolls and shall conform to the following requirements:

   a. Roll Widths: 5 feet minimum and 10 feet maximum.

   b. Roll Length: Approximately 360 feet.

   c. Weight: Approximately 0.2 pounds per square yard of fabric.

2. Fabric shall be secured in a place with wood pegs or other biodegradable materials.

3. The manufacturer shall provide moisture proof bags comparable to 4 to 6 mil opaque polyethylene bags for protection of the fabric prior to installation.

2.02 EQUIPMENT.
All equipment necessary for the satisfactory performance of this construction shall be on the project and inspected before work will be permitted to begin.

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 GENERAL
The Contractor shall notify the Purchaser at least 48 hours in advance of the time he intends to begin sowing seed and shall not proceed with such work until permission to do so has been granted by the Purchaser. Before starting seeding operations on any area, final dressing and the placing of topsoil shall have been completed in accordance with the project requirements. All seeding and related operations shall be continuous operations.

3.02 PREPARING THE SEEDBED.
Each area to be seeded shall be scarified, disked, harrowed, raked, or otherwise worked until it has been loosened and pulverized to a depth of not less than one inch. This operation shall be performed only when the soil is in a tillable and workable condition. Fertilizer, at the rate of not less than 23 pounds of Grade 6- 12-12 or equivalent, per 1,000 square feet, and agricultural limestone, at the rate of not less than 100 pounds per 1,000 square feet, shall be distributed evenly over the seedbed, unless other are specified on the plans or in the Contract Documents. The limestone and fertilizer shall be lightly harrowed, raked, or otherwise incorporated into the soil as specified above when mixed with seed in water and applied with power sprayer equipment.

3.03 TIME OF SEEDING.
Group “A” seed shall be used for seeding from February 1 to August 1, and Group “B” seed shall be used from August 1 to December 1, except that either Group “A” or “B” may be used during the month of August. Group “C” seed shall be used from February 1 to December 1 and only when specified on the Plans or in the Contract Documents. Seeding shall be performed only when the soil is in a tillable and workable condition, and no seeding shall be performed between December 1 and February 1, unless otherwise permitted.

3.04 SEEDING.
Seed of the specified group shall be sown as soon as preparation of the seedbed has been completed and thoroughly watered after seeding. Care shall be exercised to not wash seeding by over watering. Seed shall be sown uniformly by means of a rotary seeder, wheelbarrow seeders, hydraulic equipment, or other satisfactory means, and unless otherwise specified on the Plans or in the Contract Documents, at the rate of 1 ½ pounds per 1,000 square feet. Group “C” seed and seeds of legumes when sown alone shall be inoculated before sowing in accordance with the recommendations of the manufacturer of the inoculant and as directed by the Purchaser. No seeding shall be done during windy weather, or when the ground surface is frozen, wet, or otherwise non-tillable.

3.05 BIODEGRADABLE FABRIC.

A. When biodegradable fabric is specified, the fabric shall be loosely draped over the seeded area. The seed bed to be covered shall be prepared, fertilized, limed, seeded, and watered prior t installation of the fabric. If the slope is greater than 3 to 1, fabric shall be applied vertically with paper strips oriented parallel to the slope.

B. The Contractor shall dig a 4 inch deep check ditch 1 foot back from the slope crown, then fold, place and peg fabric every 9 inches in the check ditch, and cover with soil. An identical check ditch shall be provided 1 foot away from the bottom of the slope. When 2 or more lengths of fabric are required to be installed side by side to cover an area, they shall overlap

4 inches minimum. Fabric installed end to end shall overlap 4 inches minimum with the upgrade section on top of the lower grade section. End to end overlaps of adjacent rows of fabric shall be staggered a minimum of 5 feet. Each length of fabric shall be pegged in 3 rows, each edge and the center, with pegs placed on 3 foot centers maximum. Overlapped ends shall be pegged on 9 inch centers across the fabric overlap. Pegs shall be driven flush with the ground. The Contractor shall strictly adhere to the installation directions provided by the manufacturer of the fabric.

C. The Contractor shall maintain and protect the biodegradable fabric until Final Acceptance or until the Purchaser has determined that the fabric has served its useful life, whichever occurs first. Maintenance shall consist of watering as required, repairs made necessary by erosion, wind, fire, or any other cause until Final Acceptance. Following the restoration of damaged areas under plant establishment requirements for applicable underlying items, the fabric shall be repaired or replaced to meet the original requirements and maintained until Final Acceptance of the Project.

3.06 MULCHING.

When seeding with mulch is specified, the mulch material shall be spread evenly over the seeded areas at an approximate rate of 75 pounds per 1,000 square feet immediately following the seeding operations. This rate may be varied by the Purchaser, depending on the texture and condition of the mulch material and the characteristics of the area seeded. All portions of the seeded areas shall be covered with a uniform layer of mulch, so that approximately 25 percent of the ground is visible. The mulch shall be held in place by the use of an approved mulch binder. Cutback asphalt or emulsified asphalt shall be applied at the approximate rate of 4 gallons per 1,000 square feet as required to hold the mulch in place. Mulch in medians and other areas affected by traffic shall be held in place by applying asphalt binder at the approximate rate of 11 gallons per unit. The Contractor shall cover exposed structures, guardrails, signs, and appurtenances, if the mulch binder is applied in such a way that it would come in contact with or discolor the structures.

3.07 MAINTENANCE AND REPAIR.

All seeded areas shall be cared for and maintained properly to the Purchaser's satisfaction until Final Acceptance of the Work and for the duration of the warranty period. Such care shall include, but not be limited to watering as necessary, fertilizing, and mowing the seeded areas when required by the Purchaser. When mowing is required, mower blades shall be set at sufficient height to protect the vitality of the growth. Areas which have been previously seeded and mulched in accordance with this Specification Section but which have been eroded, damaged or failed to successfully establish a stand of grasses or legumes shall be repaired as directed by the Purchaser. All material and labor required to maintain and repair seeded areas shall be furnished by the Contractor at no cost to the City. If the Purchaser directs the Contractor to place additional fertilizer on the area to be reseeded, and additional 4 pounds of agricultural limestone will be required for each additional pound of fertilizer.

PART 4 – MEASUREMENT

The furnishing of seeding as specified herein may be incidental to the work of the Contract, or may be measured and payment made under the Pay Items described herein, as defined by the Pay Items in the Proposal Sheet(s) and/or as included in the Plans and Contract Documents. If payment is made separately, measurement for the work of this Specification will be as described below.

4.01 SEEDING (WITH MULCH).

The area of seeding (with mulch) to measure for payment will be the number of seeding units, with mulch, in accordance with these Specifications. Each unit will consist of 1,000 square feet measured along the surface.

4.02 SEEDING (WITHOUT MULCH).

The area of seeding (without mulch) to be measured for payment will be the number of seeding units in accordance with these Specifications. Each unit will consist of 1,000 square feet measured along the surface.

4.03 BIODEGRADABLE FABRIC.
Biodegradable fabric to be measured for payment will be the number of 1,000 square foot units for which biodegradable fabric has been applied over seeded areas. Measurement will be along the surface.

4.04 GENERAL.
All work and materials for seed bed preparation, application of fertilizer and limestone, application of mulch binder, watering and maintenance and repair of work, and all other similar items included in this section of the Specifications but not covered by a Pay Item herein will be considered as a subsidiary obligation of the Contractor under other items of the Contract.

PART 5 – PAYMENT

5.01 SEEDING (WITH MULCH).
Seeding (with mulch) will be paid for at the contract unit price per unit (1,000 square feet), for the accepted quantities, which price will be full payment for preparing the seedbed, and for furnishing and placing all materials including fertilizer, water, agricultural limestone, seed, mulch materials, mulch binder and inoculant, complete in place; and for maintenance and repair of the seeded and grassed area.

5.02 SEEDING (WITHOUT MULCH).
Seeding (without mulch) will be paid for at the contract unit price per unit (1,000 square feet) for the accepted quantities, which price will be full payment for preparing the seedbed, and for furnishing and placing all materials including fertilizer, water, agricultural limestone, seed, and inoculant, complete in place; and for maintenance and repair of the seeded and grassed areas.

5.03 BIODEGRADABLE FABRIC.
Biodegradable fabric will be paid for at the contract unit price per unit (1,000 square feet) for furnishing, installing, maintaining, and protecting the fabric, which price will be full payment for accomplishing the above.

5.04 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02920-5.01	SEEDING (WITH MULCH)	Unit of 1,000 SF
02920-5.02	SEEDING (WITHOUT MULCH)	Unit of 1,000 SF
02920-5.03	BIODEGRADABLE FABRIC	Unit of 1,000 SF

END OF SECTION
02920

SECTION 02921
SODDING

PART 1 - SCOPE

1.01 This work shall consist of furnishing and placing sod at all locations shown on the Plans or where directed by the Purchaser, and in conformity with these Specifications. Ordinarily, the work will consist of the furnishing and placing of new sod originating from sources outside the rights-of-way and easement limits. In some cases, however, the work will include removing sod from areas where the requirements of the project would destroy existing sod, storing the sod so removed, and resetting it in areas shown on the Plans or designated by the Purchaser.

PART 2 - MATERIALS AND EQUIPMENT

2.01 MATERIALS

A. Sod

1. New sod shall consist of live, dense, well rooted growth of Bermuda grass, free from Johnson grass, nutgrass, and other obnoxious grasses or weeds, well suited for the intended purpose and for the soil in which it is to be planted. All sod shall be cleanly cut in strips having a reasonably uniform thickness of not less than 2 inches and cut in 10 to 12 inch squares.

2. The sale or movement of sod for propagation is controlled by Tennessee Plant Pest Act of 1955, TCA 43-55 et. Seq., and the Contractor shall be responsible for obtaining all inspections, authorizations, and permits which may be required by such law and the Tennessee Department of Agriculture.

B. Fertilizer

1. Manufactured fertilizer shall meet the requirements of Specification Section 02920 Paragraph 2.01.B and shall be Grade 15-15-15 unless otherwise specified on the Plans or in the Contract Documents.

C. Ammonium Nitrate

1. Ammonium nitrate shall be a standard commercial product, shall conform to the requirements for other commercial fertilizers as specified in Specification Section 02920 Paragraph 2.01.B, and shall have a minimum of 33 ½ percent nitrogen.

D. Agricultural Limestone

1. Agricultural limestone shall meet the requirements of Specification Section 02920 Paragraph 2.01.C.

2.02 EQUIPMENT

A. All equipment necessary for the satisfactory performance of this work shall be on the project and approved before work will be permitted to begin.

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 WEATHER LIMITATIONS

A. Sod shall be set or reset only when the soil is moist and favorable for growth. No setting or resetting shall be done between December 1 and February 1, unless weather and soil conditions are considered favorable and permission is granted by the Purchaser.

3.02 REMOVING AND STORING SOD FOR RESETTING

A. If specified, sod removed from such areas as lawns, yards, and lots shall be so cut, handled, and stored that the sod can be reset in the same locations from which it was removed. No exchange of sod will be permitted unless approved by the Purchaser. Unless reset immediately after cutting, sod shall be stacked in piles and kept moist until reset. Sod shall be reset within 7 days after removal, unless otherwise specifically permitted by the Purchaser. Reset sod shall show vitality and growth at the time of acceptance by the City and for duration of the warranty period.

3.03 SODDING

A. The area to be sodded shall be brought to the lines and grades shown on the Plans or as directed by the Purchaser. The surface of the ground to be sodded shall be loosened to a depth of not less than one inch with a rake or other device. If necessary, it shall be sprinkled until saturated for a minimum depth of one inch and kept moist until the sod is placed. Immediately before placing the sod, fertilizer and lime shall be applied uniformly to the prepared surface of the ground. Fertilizer shall be applied at the rate of 8 pounds of Grade 15-15-15, or equivalent per 1,000 square feet. Agricultural limestone shall be applied at the rate of 100 pounds per 1,000 square feet.

B. Sod shall be placed as soon as practical after removal from the point of origin and shall be kept in a moist condition during the interim. The sod shall be carefully placed by hand on the prepared ground surface with the edges in close contact and, as far as possible, in a position to break joints. Each strip of sod laid shall be fitted and rolled using a roller of sufficient size and weight to fix the sod into place. Immediately after placing, the sod shall be thoroughly wetted and rolled with an approved roller or hand tamped, as approved by the Purchaser. Pinning or pegging shall be required on slopes greater than 2 to 1 to hold the sod in place or in other instances at the direction of the Purchaser.

3.03 MAINTENANCE AND REPAIR

A. The sod shall be watered as frequently as necessary for a period of two weeks, after which, ammonium nitrate shall be applied at the rate of 3.5 pounds per 1,000 square feet, and the sod given an additional watering. The Contractor shall not allow any equipment or material placed on any planted area and shall erect suitable barricades and guards to prevent his equipment, labor, or the public from traveling on or over any area planted with sod. Care shall include periodic watering, fertilizing and mowing necessary to maintain the vitality and appearance of the sod. When mowing is required, mower blades shall be set at sufficient height to protect the vitality of the growth. Sodded areas that become eroded, damaged or fail to successfully establish a stand of grass shall be repaired and/or replaced as directed by the Purchaser. All material and labor required to maintain and repair seeded areas shall be furnished by the Contractor at no cost to the City. Sod must be living at the time of final acceptance of the project and through the duration of the warranty period.

3.04 DISPOSAL OF SURPLUS MATERIAL

A. All surplus material shall be disposed of off-site.

PART 4 – MEASUREMENT

4.01 The furnishing and setting of sodding as specified herein may be incidental to the work of the Contract, or may be measured and payment made under the Pay Items described herein, as defined by the Pay Items in the Proposal Sheet(s), and/or as included in the Plans and Contract Documents. If payment is made separately, measurement for the work of this Specification shall be as described below.

4.02 SODDING

A. Sod will be measured for payment by the square yard of surface upon which the sod has been set.

4.03 REMOVING, STORING, AND RESETTING SOD

A. Sod to be removed, stored, and reset will be measured for payment by the square yard of surface upon which the removed sod has been reset.

PART 5 – PAYMENT

5.01 SODDING

A. Sodding will be paid for at the contract unit price per square yard for the accepted quantities, which price will be full payment for furnishing, setting, pinning and pegging if required, fertilizing, watering, mowing, providing and placing agricultural limestone, and for the maintenance and repair of the sodded area.

5.02 REMOVING, STORING, AND RESETTING SOD

A. This work will be paid for at the contract unit price per square yard for the accepted quantities, which price will be full payment for removing and storing the sod or turf, setting, pinning and pegging if required, fertilizing, watering, mowing, providing and placing agricultural limestone, and for the maintenance and repair of the sodded area.

5.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02921-5.01	SODDING (NEW SOD)	Square Yard
02921-5.02	REMOVING, STORING, AND RESETTING SOD	Square Yard

END OF SECTION
02921

SECTION 02950
REMOVAL AND REPLACEMENT OF PAVEMENTS AND INCIDENTALS

PART 1 GENERAL

1.01 SCOPE

A. This Work shall consist of the removal and replacement of pavements, sidewalks, driveway aprons, curbs and gutters, driveways, paved areas, and curbs made necessary by the improvement of sanitary sewer infrastructure, and other items of construction that require temporary cuts. Such replacement shall be to a condition at least equal to the condition existing prior to removal and of in-kind material and shall be compliance with the Drawings, these Specifications, or as directed by the Purchaser. The Work which will be included in the Subcontract and for which the Subcontractor shall be compensated therefore is limited to that area within the rights-of-way and construction easements for the Project. The Subcontractor will not be compensated for the removal and replacement of facilities outside the rights-of-way, easements, and limits of construction of the Project.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete:

1. Portland cement concrete shall be in accordance with Section 03050 Portland Cement Concrete.

B. Asphaltic Concrete Pavement:

1. Asphaltic concrete surface courses shall meet the requirements of Mix No. 1 and bases courses shall meet the requirements of Mix No. 2 as described below.

2. The composition of the mixes shall be as follows:

Total Percent Passing by Weight

Sieve Size	Mix No. 1	Mix No. 2
2”	100	100
1-1/2”	100	100
3/4”	100	100
3/8”	76-96	65-95
No. 4	51-76	45-70
No. 8	36-60	25-50
No. 30	16-40	12-30
No. 100	3-12	2-12
No. 200	2-8	1-6

3. The proportions of the total mixture, in percent by weight, shall be as follows:

Courses	Combined Mineral Aggregate	Asphalt Cement
Mix No. 1, Surface	92.0 – 96.0	4.0 – 8.0
Mix No. 2, Binder	93.0 – 97.5	2.5 – 7.0

4. It is the intent of this Section of the Specifications that the above described mixes shall conform to the following mixtures specified in the Tennessee Department of Transportation Standard Specifications for Road and Bridge construction.

   a. Mix No. 1 – Section 411, Asphaltic Concrete Surface (Hot Mix), Grading E.

   b. Mix No. 2 – Section 307, Bituminous Plant Mix Base (Hot Mix), Aggregate Grading C.

5. For multiple layer construction, succeeding layers shall not be laid until the previous layer has cooled sufficiently to support the construction equipment

6. When Mix No. 1 is to be used as a surface for traffic lanes, the mineral aggregate shall be composed of not less than 50 percent nor more than 55 percent crushed limestone and not more than 50 percent nor less than 45 percent natural sand. When Mix No. 1 is used for surfacing of shoulders or other non-traffic lane construction, the mineral aggregate may be composed entirely of limestone, including screening and manufactured sand, but in no case shall the mineral aggregate for this construction consist of less than 50 percent limestone. The natural sand shall be so graded that not more than 5 percent will be retained on the No. 4 sieve.

C. Expansion Joint Filler:

1. Preformed expansion joint filler shall be of the bituminous type, shall conform to the requirements of AASHTO M 213 and shall not be more than 1 inch or less than 1/2 inch in thickness. The filler shall be cut to the full depth of pavement, curb and gutter, sidewalk, or driveway being replaced.

D. Gravel Pavement or Base:

1. Crushed limestone with such material as manufactured sand or other fine materials naturally contained or added thereto as needed to match existing conditions and conform to the gradations shown below:

Grading Table for Graded Aggregate Base Course
Total Percent, by Dry Weight, Passing Each Sieve (U.S. Standard)

Size No.	2 ½ “	2”	1 ½”	1”	3/8”	No. 40
1	100	95-100			35-65	10-30

2.02 EQUIPMENT

A. Equipment and tools necessary for cutting, removal, and hauling of existing items; handling and placement of new material; and all equipment necessary to perform all parts of the Work shall be at the job site sufficiently ahead of the start of construction operations to be examined and approved by the Purchaser.

B. When saws are used to cut pavement, the Subcontractor shall provide sawing equipment adequate in power to complete the sawing to a minimum of 1-1/2 inches below the pavement surface in one pass. An ample supply of saw blades shall be maintained at the site of the Work at all times during sawing operations.

C. Other types of pavement cutting equipment shall be capable of cutting the pavement to a neat straight line of 1-1/2 inch minimum depth below the pavement surface in one pass.

D. The Subcontractor shall provide equipment capable of removal of pavements, sidewalks, driveway aprons, curbs and gutters, driveways, paved areas, and curbs without disturbance of adjacent items to remain in place.

PART 3 EXECUTION

3.01 REMOVAL OF ASPHALT PAVEMENT

A. Asphalt pavement shall be removed to a clean straight line as shown on the drawing details. Pavement shall be cut by saw or other equipment approved by the Purchaser in advance. Edges of existing asphalt pavement adjacent to trenches, where damaged, shall be recut in a clean straight line within the limits of damaged pavement only. Such recuts shall be parallel to the original cuts and perpendicular to the pavement surface.

3.02 REMOVAL OF CONCRETE PAVEMENT

A. Concrete pavement shall be removed to a neat straight line as shown on the drawing details. Care shall be used to avoid damage to pavements and to the pavement base remaining in place.

3.03 REMOVAL OF CONCRETE SIDEWALK, CURB AND GUTTER, AND DRIVEWAY

A. Concrete sidewalks, curbs and gutters, and driveways shall be removed to the nearest contraction or expansion joint. Care shall be used to avoid damage to sidewalks, curbs and gutters, and driveways remaining in place.

3.04 REMOVAL OF GRAVEL PAVEMENT

A. Gravel surfaces encountered in construction shall be removed as needed to allow for the adjustment of the manhole frame and cover.

3.05 REPLACEMENT OF PAVEMENT

A. Asphalt Pavements

1. Replace asphalt paving courses to match existing thickness. The minimum surface course thickness shall be 2 inches. Asphalt pavement and base replacement shall be constructed for the entire cross-section of pavement removal area including all areas where pavement was re-cut subsequent to the initial pavement removal.

B. Concrete Pavements

1. Concrete pavement shall be replaced with Class A concrete pavement equal in thickness to the pavement removed but not less than 4 inches thick. Concrete pavement and base replacement shall be constructed for the entire cross-section of pavement removal area including all areas where pavement was re-cut subsequent to the initial pavement removal.

2. Reasonable efforts shall be made to avoid contrast in the color and texture of existing and restored surfaces.

C. Placing, Curing, and Protection of Concrete

1. After the backfill in the trench has been brought to the appropriate subgrade elevation shown on the Plans, compacted to the specified density, and permission has been given by the Purchaser, a concrete slab of the appropriate thickness shall be placed within the entire disturbed area.

2. Any loose or disturbed pavement or base shall be removed prior to placement of the concrete. Concrete shall be placed only on a moist subgrade and shall not be placed unless the ambient temperature is 35° F and rising. In no case shall concrete be placed on a frozen or frosty subgrade. After the concrete is placed, it shall be struck off in an approved manner to the appropriate grade as shown on the Plans and shall be finished with floats and straight edges until the required surface texture has been obtained.

3. No vehicles or loads shall be permitted on any concrete until the Purchaser has determined that the concrete has obtained sufficient strength for such loads. The Subcontractor shall construct and place such barricades and protection devices as are necessary to protect the concrete.

3.06 REPLACEMENT OF SIDEWALKS, DRIVEWAY APRONS, CURBS AND GUTTERS, DRIVEWAYS AND OTHER PAVED AREAS, AND CURBS

A. Concrete sidewalks and driveway aprons shall be replaced in accordance with the City of Memphis Standard Construction Specifications.

B. Unless otherwise directed, curb and gutter shall be replaced with new concrete curb and gutter of the same cross-section and at the same top of curb elevation and flow line as that removed. Where curb and gutter of a different type than existing is to be used for replacement, the replacement flow line shall match existing and a transitions section provided between the existing and replacement cross-sections. Curb heights shall be transitioned at a rate of 1 inch in 5 feet. Granite curb shall be replaced with new concrete curb whose height matches existing adjacent curb top elevations. Any expansion joint material removed shall be replaced at the original locations. Existing concrete edges shall be cleaned prior to placement of concrete. The finished curb and gutter cross-section, elevations, texture, and color shall conform to the adjacent concrete surfaces.

C. Replacement of paved areas other than street pavement; concrete, asphalt, or gravel driveways; and asphalt or concrete curb within the right-of-way or construction easement limits shall be in kind for those cross-sections removed, unless directed otherwise by the Purchaser.

3.07 DAMAGE DUE TO SETTLEMENT

A. The Subcontractor shall be responsible for any damage caused by settlement of backfill placed beneath pavements, sidewalks, driveway aprons, curbs, curbs and gutters, driveways, paved areas other than street pavement, and asphalt or concrete curb within the right-of-way or construction easement limits. This includes any damage which may occur at any time prior to, and during a period of one year from the date of Final Completion of the Work covered by the Subcontract.

B. During such period, the Subcontractor shall at his own cost and expense refill all excavations where settlement damage has occurred and replace damaged pavements, sidewalks, driveway aprons, curbs, curbs and gutters, paved areas, driveways, and all other damaged items to the satisfaction of the Purchaser. Should the Subcontractor fail to repair settlement damage which may occur as described above within 5 days after being given notice thereof, the Purchaser shall have the right to repair such settlement and charge the cost of such repairs to the Subcontractor.

3.08 DAMAGE OUTSIDE CONSTRUCTION EASEMENT LIMITS

A. The Subcontractor will be held responsible for all damage to roads, highways, shoulders, curbs and gutters, ditches, embankments, bridges, culverts, and other property, caused by him or any of this Sub-subcontractors in hauling or otherwise transporting materials to and from the

several sites of Work, regardless of the location of such damage. The Subcontractor shall make arrangements relative to the payment for, or repair or replacement of, such damage or damaged surfaces or structures which are satisfactory and acceptable to the Purchaser, at the Subcontractor's cost and expense.

PART 4 MEASUREMENT & PAYMENT

4.01 MEASUREMENT

A. Pavement Removal and Replacement

1. Pavement removal and replacement shall be measured for payment by the square yard, complete in place.

B. Concrete Sidewalk Removal and Replacement

1. Sidewalk removal and replacement shall be measured for payment by the square foot, complete in place.

C. Concrete Curb and Gutter Removal and Replacement

1. Curb and gutter removal and replacement shall be measured for payment by the linear foot, complete in place.

D. Gravel Driveway and Gravel Area Removal and Replacement

1. Gravel driveways and gravel area removal and replacement shall be measured for payment by the ton of crushed limestone, complete in place.

4.02 PAYMENT

A. Pavement Removal and Replacement

1. The accepted quantities of pavement removal and replacement shall be paid for at the Subcontract unit price per square yard for the type specified, which price will be full compensation for cutting and re-cutting pavement; removal and disposal of pavement and base; preparing the subgrade; placing, finishing, curing, and protection of concrete; and placing and compacting asphaltic concrete wearing surfaces, complete in place.

B. Concrete Sidewalk Removal and Replacement

1. The accepted quantities of sidewalk removal and replacement shall be paid for at the contract unit price per square foot, which price will be full compensation for removal and disposal of sidewalk; preparing the subgrade; and placing, finishing, curing and protection of concrete, complete in place.

C. Concrete Curb and Gutter Removal and Replacement

1. The accepted quantities of curb and gutter removal and replacement shall be paid for at the Subcontract unit price per linear foot for the type specified, which price will be full compensation for removal and disposal of curb and gutter; preparing the subgrade; and placing, finishing, curing and protection of concrete, complete in place.

D. Gravel Driveway and Gravel Area Removal and Replacement

1. The accepted quantities of gravel driveway and gravel area removal and replacement shall be paid for at the Subcontract unit price per ton of crushed limestone, which price will be full compensation for preparing the subgrade and replacing the gravel, complete in place.

4.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02950-4.01.A-1	ASPHALTIC CONCRETE PAVEMENT REMOVAL AND REPLACEMENT	SQUARE YARD
02950-4.01.A-2	CONCRETE PAVEMENT REMOVAL AND REPLACEMENT	SQUARE YARD
02950-4.01.B	CONCRETE SIDEWALK REMOVAL AND REPLACEMENT	SQUARE YARD
02950-4.01.C	CONCRETE CURB AND GUTTER REMOVAL AND REPLACEMENT	SQUARE YARD
02950-4.01.D	GRAVEL DRIVEWAY AND GRAVEL AREA REMOVAL AND REPLACEMENT WITH CRUSHED STONE	TON

END OF SECTION 02950

SECTION 03050
PORTLAND CEMENT CONCRETE

PART 1 GENERAL

1.01 SCOPE

A. This specification covers the classification, materials, proportioning of materials, equipment, mixing requirements, and testing for Portland cement concrete to be used for construction of streets, bridges, and miscellaneous structures and facilities as defined in Division 2 – Site Construction of these Specifications. The classification requirements, forming, curing, measurement, and payment for specific uses of concrete are specified and defined in the appropriate sections of Division 2.

PART 2 PRODUCTS

2.01 CONCRETE CLASSIFICATION

A. Portland cement concrete used for construction of the various items covered in Division 2 of these Specifications shall be classified by usage as follows

1. Class A

    a. Class A concrete shall be used as specified for such items as concrete curb, curb and gutter, sidewalks, drainage and sewer structures other than box culverts, ditch paving, bridges (other than superstructure) and similar uses.

2. Class A S

    a. Class A S concrete shall be used for bridge superstructures and channel lining of ditches.

3. Class B

    a. Class B concrete shall be used for roadway base and pavement.

4. Class C

    a. Class C concrete shall be used as specified for such items as concrete cradles, encasements, embankment slope paving at bridge abutments, and other low strength applications.

5. Class P

    a. Class P concrete shall be used for cast-in-place box culverts and precast and precast-prestressed concrete structures or structural members. High-early-strength concrete shall be as specified in Specification Section 03050 Paragraph 6.05.

2.02 HIGH-EARLY-STRENGTH CONCRETE

A. High-early-strength concrete may be required in the Plans and Specifications or substituted at the request of the Subcontractor, subject to the approval of the Purchaser. When high-early-strength cement concrete is authorized, it shall conform to the requirements of Table 03050.2 except that the 28-day strength (or 14-day strength for Class B concrete) shall be obtained in 7 days. The use of Type I or Type III cement for high-early-strength concrete in lieu of using Type III cement. When type I cement is used, the concrete shall have a

minimum of 7.6 sacks (714 pounds) of cement per cubic yard of concrete. If admixtures are used to obtain high-early-strength concrete, such admixtures may only be used if previously approved by the Tennessee Department of Transportation for similar uses of the concrete and if specifically approved for the project by the Purchaser.

B. The gradation of fine and coarse aggregates shall be the same as that approved for the concrete for which the high-early-strength concrete is substituted. All materials entering into the high-early-strength concrete shall be of the same kind and class as the materials entering into the other part or parts of the facility constructed of the class of concrete for which high-early-strength is being substituted.

C. No additional compensation will be made if the Subcontractor elects to substitute high-early-strength concrete for any class of concrete. The unit price for the class for which the substitution is made shall be full compensation for the concrete.

2.03 MATERIALS

A. Materials used in the production of Portland cement concrete of the various classifications specified herein shall meet the following requirements.

2.04 PORTLAND CEMENT

1. Portland cement shall be Type I cement conforming to the requirements of AASHTO M 85, except that for high-early-strength concrete, Type III cement may be used.

2.05 FINE AGGREGATE.

A. Fine aggregate shall consist of natural sand, clean and free from any surface film or coating and graded from fine to coarse. Fine aggregate shall conform to the requirements of ASTM C 33 and the specifications included herein. The amount of deleterious substance shall not exceed the following percentage by weight:

1. Removed by decantation…… 3 percent

2. Coal or lignite…… 1 percent

3. Clay lumps…….. 1 percent

4. Other local deleterious substances (such as shale, alkali, Mica, coated grains, soft and flaky particles) …… 1 percent

5. Total coal, clay lumps, shale, soft fragments and other local deleterious substances ……. 5 percent

B. All fine aggregate shall be free from amounts of organic impurities that would be detrimental to concrete strength and durability. Aggregate shall be subjected to the colorimetric test made in the field as follows:

1. Fill a 12 oz. graduated bottle to the 4 ½ oz. mark with the sand to be tested. Add a 3% solution of sodium hydroxide until the volume, after shaking, amounts to 7 ounces. Shake thoroughly and let stand for 24 hours. The sample shall then show a practically colorless solution, or at least, a solution not darker than straw color.

C. Fine aggregate shall be well graded from coarse to fine and, when tested by means of laboratory sieves, shall conform to the following requirements:

Passing	Percent
3/8 in. Sieve	100
No. 4 Sieve	95 to 100
No. 16 Sieve	50 to 90
No. 50 Sieve	10 to 30
No. 100 Sieve	0 to 10
No. 200 Sieve	0 to 3

a. Note: Not more than 45% should be retained between any two consecutive sieves.

D. Fine aggregate shall be of such quality that mortar composed one (1) part Portland cement and three (3) parts fine aggregate, by weight when made into briquets or cylinders, shall show a tensile or compressive strength at seven (7) and twenty-eight (28) days at least equal to the strength of briquets or cylinders composed of one (1) part of the same cement and three (3) parts standard Ottawa sand by weight. The percentage of water used in making the test specimens of cement and fine aggregate shall be such as to produce a mortar of the same consistency as that of the Ottawa sand test specimens of standard consistency.

2.06 COARSE AGGREGATE

A. Coarse aggregate for any class of Portland cement concrete shall consist of crushed stone or crushed or uncrushed gravel unless otherwise specified.

B. Coarse aggregate for Class A, Class B, or Class C concrete shall be furnished in two sizes: Size No. 4 and Size No. 67 as shown hereinafter in Table 03050.1, Coarse Aggregate Gradation Table. The two sizes shall be manufactured, within the specified limits, to produce Size No. 467 when combined in the proper proportions at the batching plant. If the supplier provides a proper stockpile to prevent segregation, then a combined Size No. 467 can be used in lieu of blending Size No. 4 and Size No. 67.

C. Coarse aggregate for Class AS concrete shall be Size No. 57. Only limestone coarse aggregate will be used for Class AS concrete; gravel coarse aggregate will not be permitted.

D. Coarse aggregate for Class P concrete shall be size No. 57 or Size No. 67 as may be specified or directed. Only limestone coarse aggregate shall be used for Class P concrete; gravel coarse aggregate will not be permitted.

E. Coarse aggregate for concrete curbing placed by machine extrusion methods shall be Size No. 57 or Size No. 67.

F. The coarse aggregates shall otherwise conform to the requirements of AASHTO M 80 and ASTM C 33 with the following exceptions and stipulations:

1. Deleterious Substances: The amount of deleterious substances shall not exceed the following limits:

	Maximum Percent by Weight
a. Soft or nondurable fragments (fragments which are structurally weak such as shale, soft sandstone, limonite concretions, gypsum, weathered schist or cemented gravel) ……	3.0
b. Coal and lignite ……	1.0
c. Clay lumps ……	0.25
d. Material passing the No. 200 sieve ……	1.00
e. Thin or elongated pieces (length greater than 5 times average thickness)	10.00
f. Other local deleterious substances	1.00

i. Notes:

(1) In the case of crushed aggregate, if all the material finer than the 200-mesh sieve consists of the dust of fracture essentially free of clay or shale, Item 4, Maximum Per Cent by Weight, may be increased to 1.5.

(2) The sum of the percentages of Items No. a, b, c, d, and f shall not exceed 5.0.

(3) When the coarse aggregate is subjected to five alternations of the sodium sulfate soundness test, the weighted percentage of loss shall be not more than nine.

(4) Alternate freeze/thaw tests for soundness will not be performed.

(5) The percentage of wear as determined by AASHTO T 96 shall not exceed 40.

COARSE AGGREGATE GRADATION TABLE
Table 03 05 00.1

Size Number	Amounts Finer Than Each Lab. Sieve (Sq. Openings), % By Weight							
	2”	1-1/2”	1”	¾”	½”	3/8”	No. 4	No.8
4	100	90-100	20-55	0-15	----	0-5	----	----
467	100	95-100	----	35-70	----	10-30	0-5	----
57	----	100	95-100	----	25-60	----	0-10	0-5
67	----	----	100	90-100	----	20-55	0-10	0-5

2.07 WATER

A. The water used in mixing concrete shall be clean, free from oil, acid, strong alkalis, organic or vegetable matter.

2.08 AIR-ENTRAINING ADMIXTURES

A. Air-Entraining Admixtures shall conform to the requirements of AASHTO M 154, except that the tests for bleeding, bond strength and volume change will not be required.

B. The Purchaser will maintain a list of qualified products. The Subcontractor shall be required to furnish a material that appears on this list.

C. A product may become approved by furnishing test data from a recognized laboratory showing that the air-entraining admixture proposed for use conforms to the requirements of these Specifications. A recognized laboratory is defined as one of the following: A State Transportation Department Laboratory; a Federal Highway Administration Laboratory; or other laboratories which are approved by the Purchaser.

2.09 CHEMICAL ADDITIVES

A. For Portland cement concrete mixtures, these additives shall conform to the requirements of AASHTO M 194 covering the following five types:

1. Type A – Water reducing admixtures

2. Type B – Retarding admixtures

3. Type C – Accelerating admixtures

4. Type D – Water reducing and retarding admixtures

5. Type E – Water reducing and accelerating admixtures

B. Additionally, admixtures for increasing the flowable characteristics of concrete (super plasticizers) may be used, subject to the approval of the Purchaser for each class and intended use of the concrete. Such admixtures shall meet the applicable requirements of ASTM C 494. The use of a plasticizer shall not change the maximum water requirements for the approved design mix. When approved for use, the admixture shall be introduced into the mix in the manner and quantities recommended by the manufacturer.

C. Additives listed in items A through E above and super plasticizers may only be used with the written approval of the Purchaser. Before any admixture is approved, the manufacturer of the admixture or the Subcontractor shall furnish the Purchaser documentary evidence that the material proposed for use has been tested in accordance with the methods of test specified in AASHTO M 194 (or ASTM C 494 for super plasticizers) and meets the requirements of the Specification. Documentary evidence for all additives shall be the results of tests conducted by a testing laboratory inspected at regular intervals by the National Bureau of Standards. The Purchaser may require a notarized certification from the manufacturer of any additives used stating that the material is identical with that originally approved and has in no way been changed or altered. Even through additives have been approved by the Purchaser, the Subcontractor shall be responsible for the successful use of the additives. No reduction in the cement content of the concrete as designed without chemical additives will be made when additives are permitted.

D. Calcium chloride additives will not be permitted.

2.10 CURING MATERIALS

A. Curing materials shall be as specified in the various Specification Sections of Division 2 and as specified below:

B. Water

1. Water used in curing Portland cement concrete shall be free from any substance which may be injurious to concrete when applied on the surface as a curing agent.

C. Burlap

1. Burlap shall conform to AASHTO M 182, Class 3 or Class 4. If Class 1 or Class 2 burlap is permitted, at least two layers shall be use.

D. Liquid Membrane-Forming Compounds

1. These compounds shall conform to AASHTO M 148. Where applied texture finish is specified, a Type 1-D, Class B, membrane which is compatible with the texture finish shall be used. Type 2 (white pigmented) membrane shall be used in all other applications, unless otherwise specified.

E. White Polyethylene Sheeting

1. This material shall conform to AASHTO M 171.

2.11 FLY ASH

A. Class C fly ash conforming to the requirements of ASTM C 618-84 may be used as a replacement for Portland cement if approved in writing by the Purchaser. The maximum amount of cement being replaced by fly ash shall not exceed 15 percent. Before any fly ash will be approved for use, the Subcontractor shall furnish the Purchaser documentary evidence that the fly ash proposed for use has been tested in accordance with ASTM C 311-7 and meets the requirements of that specification. Documentary evidence shall be the results of tests conducted by a testing laboratory inspected at regular intervals by the National Bureau of Standards. Even though the fly ash has been approved by the Purchaser, the Subcontractor shall be responsible for its successful use. When a specific air content has been required and fly ash is being used, the air content shall be tested on each truck load of concrete at the batch plant and the tested value shall be indicated on the ticket.

2.12 EQUIPMENT

A. General

1. Equipment and tools necessary for handling materials and performing all parts of the Work shall be subject to the approval of the Purchaser. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved. The equipment and organization shall be of sufficient capacity to accomplish the maximum continuous concrete placement, as governed by the construction joints shown on the Plans and Design Standards or as directed by the Purchaser.

2.13 BATCHING PLANT AND EQUIPMENT

A. General

1. The batching plant shall include bins, weighing hoppers, and scales. If cement is used in bulk, a bin, hopper, and separate scale for cement shall be included. The Subcontractor shall provide adequate means for cement cut off checks. The weighing hoppers shall be properly sealed and vented to preclude dusting during operation. The bulk cement

storage bin or hopper shall be provided with adequate means for sampling the cement in storage.

B. Bins and Hoppers

1. Bins with adequate separate compartments for fine aggregates, each size of coarse aggregate, and cement shall be provided in the batching plant. Each compartment shall discharge efficiently and freely into the weighing hopper. Means of control shall be provided so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly and shut off with precision. A port or other opening shall be provided for removing an overload of any one of the several materials from the hopper. Weighing hoppers shall be constructed so as to eliminate accumulations of tare materials and to discharge fully without jarring the scales. Partitions between compartments, both in bins and in hoppers, shall be ample to prevent spilling under any working conditions.

C. Scales

1. The scales for weighing aggregates and cement shall be of either the beam type or the springless-dial type. They shall be accurate within 0.5 percent throughout the range of use. The value of the minimum graduation on the scale for weighing cement shall not be greater than 5 pounds. The value of the minimum graduation on the scale for weighing amounts of aggregates up to 10,000 pounds or more shall be not greater than 10 pounds. The value of the minimum graduation of scales used in weighing amounts of aggregate 10,000 pounds or more shall be not greater than 0.1 per cent of the nominal capacity of the scales but shall not exceed 50 pounds. When beam type scales are used, provision, such as a “tell-tale” dial, shall be made for indicating to the operator that the required load in the weighing hopper is being approached. The “tell-tale” device on weighing beams shall indicate critical position clearly. Poises shall be designed so that they cannot be easily removed from the beam and can be held firmly in place. The weigh beams and “tell-tale” device shall be in full view of the operator while charging the hopper, and he shall have convenient access to all controls.

2. Scales shall be tested no less than once monthly by a certified scale testing company. Testing shall meet the requirements of applicable City ordinances and State law. The Subcontractor shall have available not less than 10 standard 50 pound weights meeting the requirements of the U.S. Bureau of Standards for calibrating and testing weighing equipment. The person dispensing weighed material shall certify that the amounts of materials used is in accordance with quantities shown on the delivery ticket.

D. Equipment for Structural Concrete

1. The requirements for batching plants shall be as prescribed above, except that when approved by the Purchaser, the requirement for storage compartments in addition to weigh bins, for fine and coarse aggregates may be waived, provided the batching tolerances specified in Specification Section 03050 Paragraph 5.02.A are maintained.

2. Ample and satisfactory equipment for conveying concrete from the mixer to final position in the forms shall be provided. Closed chutes or pipes shall be used when concrete is to be dumped or dropped for a distance greater than 5 feet. Where steep slopes are required, the chutes shall be equipped with baffle boards or shall be in short lengths that will enable the direction of movement to be reversed. Tremies for placing seal concrete under water shall consist of a water tight tube 10 inches to 14 inches in diameter. It shall be constructed so that the bottom can be sealed and opened after it is in place and fully charged with concrete. It shall be supported so that it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow.

2.14 MIXERS

A. General

1. Concrete may be mixed at a central point or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum, in terms of mixing and agitating capacity, and the speed of rotation of the mixing drum or blades for both mixing and agitation.

2. Mixers shall be capable of combining the aggregates, cement, additives when specified, and water into a thoroughly mixed and uniform mass within the specified mixing period. They shall have a minimum capacity sufficient to comply with minimum production requirements.

3. Mixers shall be equipped with an approved device for accurately measuring water within a range of error of not more than one percent. The amount of water used in each batch shall be shown by an indicator which is accurately calibrated and easily read.

4. Central plant mixers shall be equipped with an approved batch meter and timing device which will automatically lock the discharge lever during the full time of mixing and release it at the end of the mixing period. This device shall be equipped with a bell or other suitable warning device that will give a clearly audible signal each time the lock is released. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, providing the Subcontractor furnishes a satisfactory means of determining the mixing time.

B. Mixers at Site of Construction

1. Mixers at the site of construction will not be permitted, unless permitted by the Purchaser.

C. Truck Mixers and Truck Agitators

1. Truck mixers used for mixing and hauling concrete and truck agitators used for hauling central-mixed concrete shall meet all the applicable requirements under Paragraph A above, and in addition, the manufacturer's plate shall indicate the various uses for which the equipment is designed, the gross volume of the drum, and the minimum and maximum speed of rotation of the drum or blades for charging, mixing and agitating. Trucks equipped for mixing shall be equipped with an approved device for recording the number of revolutions of the drum or blades. Mixers or agitators used to mix and transport paving concrete shall be of the hydraulic drum lift type or other especially designed types which will discharge low slump concrete (1 – 2 ½ inch) at a satisfactory rate without segregation.

D. Non-agitator Trucks

1. Bodies of non-agitator hauling equipment for concrete shall be smooth, mortar tight, metal containers, and shall be capable of discharging the concrete at a satisfactorily controlled rate without segregation. Covers shall be provided when needed for protection of the concrete. Non-agitator trucks may be used only with approval of the Purchaser.

E. Admixture Induction

1. A satisfactory method and equipment for setting the dosage for admixtures must be furnished and if admixtures other than air entraining agents are used, they shall be added in the manner and in the dosage recommended by the manufacturer.

F. Vibrators

1. Vibrators shall be of an approved type and design, and shall operate under load at the rate as recommended by the manufacturer and approved by the Purchaser. For concrete structures, all concrete to be vibrated shall be compacted by means of approved high frequency internal vibrators or other approved types of vibrators immediately after being deposited in the forms. At least two vibrators in good operating condition and tow sources of power shall be available at the site where more than 25 cubic yards of concrete are to be poured. The use of external vibrators for compacting concrete will be permitted where the concrete is inaccessible for adequate compaction, provided the forms are sufficiently rigid to prevent displacement or damage from external vibration and approved by the Purchaser. For concrete pavement, the frequency of surface vibrators shall not be less than 3,500 impulses per minute and the frequency of the internal type shall not be less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators. When spud type internal vibrators, either hand operated or attached to spreader or finishing machines, are used adjacent to forms, they shall have a frequency not less than 7,000 impulses per minute. For prestressed concrete, all concrete shall be thoroughly compacted with approved high frequency vibrators operating at a minimum of 7,000 vibrations per minute.

PART 3 EXECUTION

3.01 HANDLING BATCHING AND MIXING

A. Stockpiling Aggregates

1. Sites for aggregate stockpiles shall be grubbed and cleaned prior to storing aggregates, and the ground shall be firm and smooth and well drained. A cover of at least three inches of aggregate shall be maintained in order to avoid the inclusion of soil or foreign material. The stockpiles shall be built in layers not exceeding four feet in height, and each layer shall be completely in place before the next layer is started so as to prevent segregation. The material shall be deposited in such manner as to prevent coning, except in the case of aggregate composed essentially of material finer than the No. 4 sieve and base material.

2. Dumping, casting or pushing over sides of stockpiles will be prohibited, except in the case of aggregate for base material and fine aggregate materials.

3. Unless otherwise authorized, aggregates from different sources, different gradings or differing in specific gravity by more than 0.03 shall not be stockpiled together. Stockpiles of different types or sizes of aggregates shall be spaced far enough apart, or separated by suitable walls or partitions, to prevent the mixing of the aggregates.

4. When it is necessary to operate trucks or other equipment on a stockpile in the process of building the stockpiles, it shall be done in a manner approved by the Purchaser. Any method of stockpiling aggregate which allows the stockpile to become contaminated with foreign matter or causes excessive degradation of the aggregate will not be permitted. Excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile over which equipment has operated, and failure of such samples to meet all grading requirements for the aggregate shall be considered cause for discontinuance of such stockpiling procedure.

5. Stockpiles shall be maintained in a saturated surface dry condition to the extent possible.

3.02 HANDLING, MEASURING AND BATCHING MATERIAL

A. General

1. The batch plant site, layout, equipment and provisions for transporting material shall be such as to assure a continuous supply of material to the Work.

2. Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to maintain a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain high or non-uniform moisture content, storage or stockpile periods in excess of 12 hours may be required by the Purchaser. The Purchaser may require sprinkling of aggregate that has dried to the extent that it absorbs mixing water.

3. The fine aggregate and each size of coarse aggregate shall be separately weighed into the hopper or hoppers in the respective amounts set by the Subcontractor and approved by the Purchaser. Cement shall be measured by the sack or weight. Separate scales and hoppers shall be used for weighing the cement. The scales shall be equipped with a device to indicate positively the complete discharge of the batch of cement into the batch box or container. Ninety-four pounds of bulk cement shall be considered one sack. Batches involving fractional sacks will not be allowed except when bulk cement is used.

4. Batching plants equipped to proportion aggregates and bulk cement by weight by means of automatic and interlocked proportioning devices of approved type may be used.

5. Batching shall be so conducted as to result in the required weights of each material being within a tolerance of 1.0 percent for cement and 1.5 percent for aggregates.

6. Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within a range of error of not over 1.0 percent. Unless otherwise permitted, calibrated tanks for measuring water shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve to provide for checking the setting unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank.

7. The use of chemical additives shall be as prescribed under Paragraph 3.06 of this Specification and they shall be added to the mix using the methods and at the time and in the manner recommended by the manufacturer of the additive, subject to approval by the Purchaser.

8. Unless specifically provided in the contract, the furnishing and use of approved additives or admixtures and the other precautions necessary to provide satisfactory concrete and concrete products shall be considered subsidiary to the furnishing and placement of the concrete and any and all additional costs related thereto and risks resulting there from shall be borne by the Subcontractor.

9. Different types of cement shall not be mixed, nor shall they be used alternately. Where it is necessary for the color of the concrete to be uniform, only those cements which will produce similar color in concrete may be used alternately. The Purchaser shall designate which cements may be used alternately.

10. Air entraining agents shall be added to the mix by an approved procedure and by the use of an approved dispenser to assure an accurate proportioning of the agent.

11. All admixtures shall be measured with an accuracy of plus or minus 3.0 percent.

B. Limitations on Concrete Operations

1. Mixing of concrete shall be discontinued in time to allow finishing to be completed in daylight hours, unless an adequate and approved artificial lighting system is provided and operated.

2. When concrete is being placed during hot weather, appropriate measures shall be taken to reduce the hazards of increased rate of cement hydration and high concrete temperatures. The temperature of the concrete at point of discharge shall not exceed 90^0 F. The Purchaser may require any or all, but not limited to, the following precautions to reduce the temperature of the concrete:

   a. Sprinkle coarse aggregate stockpiles in a manner so as to distribute the water evenly and to prevent a variation of moisture within the stockpile.

   b. Use crushed or chipped ice as a portion of the mixing water, or use water cooled by refrigeration or other means. If ice is used, it shall be substituted on a pound for pound basis for water and completely melted before the concrete is discharged from the mixer.

   c. The Subcontractor may employ other means which he may have at his disposal if approved by the Purchaser. In order to minimize the number and extent of precautions as indicated during the production and use of concrete during hot weather, the Subcontractor may use approved chemical admixtures for set-retarding purposes, with the Purchaser's approval. However, the use of such approved set-retarding admixtures shall not relieve the Subcontractor of the necessity for other precautions deemed necessary to minimize variability of the physical characteristics, strength, and other requirements of the green concrete.

   d. Unless authorized in writing by the Purchaser, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40^0F (if the temperature is expected to reach 35^0F or below), and not resumed until an ascending air temperature in the shade and away from artificial heat reaches 35^0F.

   e. When concreting at temperatures above 35^0F, the aggregates or water shall be heated or cooled if necessary, prior to being placed in the mixer so that the temperature of the resultant mixture will be not less than 50^0F nor more than 90^0F at the time of placement. If heating is required, the apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible occurrence of overheated areas which might injure the concrete.

   f. When concreting is authorized at temperatures 35^0F or less, the Purchaser will require the water or the aggregates or both to be heated to not less than 70^0F nor more than 150^0F. The temperature of the mixed, heated concrete shall be not less than 50^0F nor more than 100^0F at the time of placement. No concrete shall be placed on frozen grade nor shall frozen aggregates be used in the concrete.

   g. When it is expected that the ambient temperature will drop below 35^0F, the Subcontractor shall provide sufficient canvas and framework, other types of housing, or to enclose and protect the concrete in such a way that the air surrounding the

fresh concrete can be maintained at a temperature of not less than 45^0F and the temperature of the concrete shall not exceed 80^0F. The above conditions shall be maintained for a period of 120 hours after the concrete is placed. The Subcontractor shall be responsible for the quality of concrete placed during cold weather, and any concrete injured by frost action or freezing shall be removed and replaced at the Subcontractor's expense. When impending weather conditions indicate the possibility of the need for such temperature protection, all necessary heating and covering material shall be on hand ready for use before the Purchaser's permission is granted to begin placement.

3.03 MIXING CONCRETE

A. General

1. The concrete may be mixed in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity, and shall comply with the applicable requirements of Paragraph 4.03 of this Specification Section. Mixers shall be cleaned at suitable intervals. Equipment having components made of aluminum or magnesium alloys which would have contact with plastic concrete during mixing, transporting or pumping of Portland cement concrete, shall not be used.

2. The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. Mixing time shall be measured from the time all materials except water are in the drum. The flow of water shall be uniform, and all water shall be in the drum buy the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the flow of materials into the drum.

3. When mixed in a central mixing plant, the mixing time shall not be less than 60 seconds nor more than 90 seconds. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers shall be included in the mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

4. The mixer shall be operated at the drum speed recommended by the manufacturer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Subcontractor at his expense. Mixers for central mix plants shall not be operated at a capacity greater than the manufacturer's guaranteed mixing capacity.

5. Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators or non-agitating trucks having special bodies. The time elapsing from the time water is added to the mix until the concrete is deposited in place at the site of the Work shall not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 60 minutes when hauled in truck mixers or truck agitators. When high early strength concrete is used, agitator trucks only shall be used and the concrete shall be deposited in place at the site of the Work within 30 minutes from the time water is added to the mix, regardless of the method of transportation, unless otherwise approved by the Purchaser.

6. Truck mixers and truck agitators used to transport concrete from a central mixing plant and truck mixers used to mix concrete in transit from a central batching plant shall meet all applicable requirements of Paragraph 4.03 of the Specification Section, and in addition, the mixing speed and agitating speed shall be those recommended by the manufacturer of the mixer and the total revolutions at mixing speed shall not be less than 70 nor more than 100. Truck mixers and truck agitators shall be operated within the capacity recommended by the manufacturer.

7. Retempering concrete by adding water or by other means will not be permitted. Concrete

that is not within the specified slump limits at time of placement shall not be used. Admixtures for increasing the workability or for accelerating the set will be used only when provided for in the Contract, or permitted by the Purchaser. The addition of admixtures to the mix shall be in accordance with the provisions of Paragraph 5.02.A of this Specification Section.

8. Tests for air content shall be made on samples of fresh concrete when and as directed. The air content shall be that specified under Part 6 of this Specification Section and shall be determined in accordance with AASHTO T 152, T 196 or T 199.

B. Ready Mixed Concrete

1. Ready mixed concrete shall fully comply with ASTM C 94 for Ready Mixed Concrete and to the requirements of these Specifications. Ready mixed concrete shall be discharged from the mixer within 1 hour after the introduction of water, provided the air temperature or the concrete temperature does not exceed 70^0F. When the air temperature or concrete temperature exceeds 70^0F, the elapsed time between the addition of water to the mix and discharge shall not exceed 30 minutes. The 30-minute time limit for temperatures exceeding 70^0F may be extended to 1 hour, provided an approved admixture is used. The admixture shall be a water reducing and retarding agent meeting the requirements of Paragraph 3.06, Type D of this Specification Section and shall be used in accordance with the provisions of Paragraph 5.02.A of this Specification Section. The ready-mix plant furnishing the concrete shall have been inspected and approved for use as provided for in Part 4 of this Specification Section.

2. The delivery ticket accompanying each load of concrete shall show the class and quantity of concrete, the quantity of cement, aggregates, water, and additive used in the batch, and the time of batching. Materials used in the concrete shall be tested and approved.

3.04 MIX DESIGN AND PROPORTIONING

A. GENERAL

1. A Concrete Classification Table, Table 03050.2 is provided hereinafter to indicate to the Subcontractor the five classes of concrete to be use. The table contains certain criteria to be met in the design of job mixes for the different classifications of concrete. Data included are the minimum 28-day compressive strength of the concrete (14-day strength for Class B concrete), the range of slum allowed, the minimum cement content of the concrete, and the maximum water allowed. The Subcontractor shall be responsible for design of the concrete mix to be used for each classification of concrete within the limits of Table 03050.2, and for providing concrete to the Purchaser in accordance with the approved design mixes.

2. Unless otherwise specified in the Contract Documents all concrete shall contain an air entraining admixture. The concrete shall contain between 5 percent and 8 percent entrained air. Other admixtures may be used if specifically approved by the Purchaser. The use of calcium chloride will not be allowed.

3. The Purchaser may specify differing compressive strengths for the several classifications by notation on the Plans or in the Special Provisions, and those values shall govern over the values of these Specifications.

CONCRETE CLASSIFICATION TABLE

Table 03 05 00.2

Minimum #/CY Class Of Concrete	28-Day Limestone Compressive Strength (psi)	(i) (3) Min. Cement Factor-Sacks/CY Slump In Inches	Gravel Course Aggregate	Limestone Course Aggregate	(3) Min. Cement Factor-#/CY Gravel Course Aggregate	Limestone Course Aggregate	(3) Net Water Max. Gals./CY Gravel Course Aggregate	Limestone Course Aggregate	(3) Net Water Max- Gravel Course Aggregate	
A 3,000	3-5	6.0	5.5	564	517	36	33	300	275	
AS	4,000	3-5	**(2)**	6.2	**(2)**	583	**(2)**	37.2	**(2)**	310
B 3,500 **(1)**	1-2 ½	6.2	5.8	583	545	34.1	31.9	284	266	
C 2,500	2-4	5.0	4.5	470	423	34	30.6	283	255	
P 5,000	1-3	**(2)**	7.0	**(2)**	658	**(2)**	35.0	**(2)**	292	

(2) Minimum compressive strength @ 14 days. Minimum flexural strength @ 14 days of 550 psi per AASHTO T 22.
(3) Gravel Coarse Aggregate no permitted.
(4) Tabulated valves are for Type I cement conforming to the requirements of AASHTO M 85 only.

3.05 MIX DESIGN

A. Prior to mixing any concrete for the project, the Subcontractor shall submit his proposed design mix and reports of tests for each classification of concrete to the Purchaser for approval. The design mix shall be submitted on a form that indicates the supplier and type of the concrete and materials to be used as well as the amounts of materials per cubic yard for at least the following items and units (based upon saturated surface dry aggregate):

1. Cement-Pounds
2. Coarse Aggregate-Pounds
3. Fine Aggregate-Pounds
4. Air Entraining Admixture – Ounces
5. Other Admixtures (if allowed) – Ounces
6. Water – Pounds
7. Fly Ash (if allowed) – Pounds

3.06 PROPORTIONING

A. Each class of concrete shall be manufactured by combining the several materials prescribed in the design mix in the proportions necessary to obtain the specified compressive strength for each class. Proportioning shall be based upon the specified cement content, and the amount of water for each class of concrete shall not exceed the quantity shown in Table 03050.2. Below this limit, the quantity of water shall be adjusted to meet the slump requirements. Aggregate weights shown in the Subcontractor's mix design(s) shall be based on saturated surface dry aggregate; batch weights shall be corrected to compensate for surface moisture on the aggregate in order to determine the amount of water to be added at the mixer.

B. In addition to the requirements specified herein and on Table 03050.2, Portland cement concrete for pavement, Class B, (Specification Section 02750) shall have a flexural strength at 14 days of not less than 550 pounds per square inch when tested in accordance with AASHTO T 22.

3.07 CHANGES IN MIX

A. When approved by the Purchaser, the ration of coarse and fine aggregate may be adjusted in order to assure better workability or to accommodate placement by pumping. However, in no case shall the fine aggregate exceed 44 percent of the total aggregate.

B. If during the progress of the Work, the specific gravity of one or both of the aggregates change more than plus or minus 0.03 from those shown on the concrete design, the design weights shall be adjusted by a design change to conform to the new specific gravity.

3.08 TESTING

A. Test Samples

1. The Purchaser shall provide for all test cylinders. All samples shall be cast, cured and tested by the Purchaser at its expense. The Subcontractor will be required to assist the Purchaser in securing necessary materials for casting the required number of cylinders.

Testing ages will be 7 days and 28 days unless otherwise determined by the Purchaser. Laboratory cylinders shall be used to determine the quality of concrete produced. The number of cylinders to be cast daily for any quantity of concrete and laboratory tested, shall be specified by the Purchaser. With prior consent of the Purchaser, the Subcontractor may prepare field cylinders. These cylinders may be used as a gauge for early safe removal of forms where the Subcontractor requests earlier removal than set out in the Specifications.

B. Cement Testing

1. All cement used in the Work shall be pre-tested before use. Cement may be used upon completion of a satisfactory 3-day physical test made in accordance with current ASTM Specifications. Cement shall be tested by an approved commercial testing laboratory at the Subcontractor's expense.

C. Core Samples

1. If the Purchaser's testing of cylinders indicates compressive strength less than required in Table 03050.2 for the class of concrete specified, the Subcontractor may, at his option, elect to drill core samples from the actual concrete placed. If the Subcontractor elects to drill (or is instructed by the Purchaser to drill) core samples from the hardened concrete, the costs of obtaining the cores and of repairing the core holes with non-shrinking grout shall be borne by the Subcontractor.

2. The cores shall be drilled as directed by the Purchaser, at the same approximate locations from which the test cylinder concrete was obtained. The locations of the drilled cores shall be selected so that the remaining structure will not be impaired or sustain permanent damage after the holes are repaired by the Subcontractor. The drilled samples shall be tested for compressive strength by the Purchaser, and the equivalent 28-day strength of the concrete placed and represented by the drilled core samples shall be determined. The Purchaser shall use the test results of the drilled cores to determine the acceptability of the concrete.

3.09 METHODS OF SAMPLING AND TESTING

A. Test cylinders cast to determine acceptability for minimum AASHTO strength requirements shall be made and cured in accordance with AASHTO T 23 and tested in accordance with AASHTO T 22. Test cylinders cast to determine when a precast unit or a structure may be put into service or to determine when a tensioning load may be transferred shall be cured by methods identical to those used in curing the concrete member, and tested in accordance with AASHTO T 22.

B. Drilled core samples shall be taken and tested in accordance with AASHTO T 24. Due to possible fracturing effect of the coring operation, drilled core samples having a compressive strength of 85 per cent or more of specified strength will be considered acceptable.

C. Slump shall be determined in accordance with AASHTO T 119 on the job site during each placement.

D. The amount of air entrained shall be determined by pressure or volumetric meters of approved design and in accordance with AASHTO Method T 152 or AASHTO Method T 196, except that AASHTO Method T 199 may be used after the accuracy of the Chace Air Indicator has been determined by comparison tests.

3.10 CONCRETE FAILING TO MEET STRENGTH REQUIREMENTS

A. Concrete which has been mixed and placed in accordance with these Specifications, and which fails to meet the minimum 28-day strength requirements shall be removed and disposed of by the Subcontractor, at his expense, unless specifically authorized by the Purchaser, in writing, to remain in place. The removal shall be in such manner as will not cause damage to the remaining concrete or to other structural units or other facilities and property.

B. The Purchaser may, at his discretion, allow concrete which fails to meet the minimum strength requirement to remain in place. Payment for this concrete will be at a reduced price, to compensate the Purchaser for loss of durability. The amount of the reduction shall be determined by the Purchaser and shall be based on the particular circumstances.

3.11 MISCELLANEOUS

A. Concrete Mixed and/or Batched Off Project Site

1. Concrete may be mixed and/or batched off the immediate project site, subject to specific approval of the Purchaser and under the direct supervision of the Subcontractor. A delivery ticket (certified by the batch plant) showing mix, quantity of cement, quantity of fine and coarse aggregate, moisture content, total water and gallons per cubic yard of concrete shall be furnished to the Purchaser with each delivery of concrete and the Subcontractor shall show to the satisfaction of the Purchaser that the plant is so located and equipped as to produce and deliver concrete fully meeting the specification requirements.

PART 4 MEASUREMENT AND PAYMENT

The methods of measurement and payment for concrete shall be as specified in Divisions 2 and 3 of these Specifications for each particular item constructed by the Subcontractor.

END OF SECTION 03050

SECTION 03310
CONCRETE STRUCTURES

PART 1 GENERAL

1.01 SCOPE

A. This work shall consist of the construction of all structures, or parts of structures, composed of Portland cement concrete whether plain, reinforced, or a combination of both. Concrete structures shall be constructed of Class A Concrete, unless otherwise specified. They shall be constructed on prepared foundations, at the locations indicated or directed in conformity with the dimensions, lines and grades shown on the Plans or as directed by the Purchaser and in accordance with these Specifications.

B. The concrete used in this construction shall be composed of a mixture or mixtures of Portland cement, aggregates, air-entraining agents, water, and chemical additives when approved, combined by the methods an in the proportions defined for the particular class of concrete designated as shown in Specification Section 03050.

C. Parts of a structure, or structures, indicated to be constructed with materials other than Portland cement concrete and concrete reinforcement steel shall be constructed in accordance with the provisions set out in the Specification Section covering the particular type of construction.

PART 2 PRODUCTS

2.01 MATERIALS

Materials used in this construction shall meet the requirements of the applicable Sections or Paragraphs of Specification Section 03 05 00, “Portland Cement Concrete” and the following:

A. Waterstops

1. Waterstops shall be of the type, shape, and dimension shown on the Plans.

2. Metallic: Metallic waterstops shall be sheet copper conforming to the requirements as specified in the current Specifications for Copper Sheet, Strip, Plate, and Rolled Bar, Type ETP, ASTM Designation B 152. The weight per square foot shall be as specified on the Plans.

3. Nonmetallic:

a. Nonmetallic waterstops shall be manufactured from either natural rubber, synthetic rubber, or polyvinylchloride (PVC) at the option of the Subcontractor. Waterstops shall be produced by such a process that, as supplied for use, they will be dense, homogeneous, and free from holes and other imperfections. The cross-section of the waterstop shall be uniform along its length and transversely symmetrical so that the thickness at any given distance from either edge of the waterstop will be uniform.

b. Rubber Waterstop:

i. The waterstop shall be fabricated from a high grade thread-type compound. The basic polymer shall be natural rubber or a copolymer of butadiene and styrene, or a blend of both. The compound shall contain no less than 70 percent by volume of the basic polymer, and remainder shall consist of reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents and plasticizers, but shall contain no factice.

ii. Samples taken from the finished waterstop shall meet the following requirements when tested in accordance with the current specified ASTM method of test.

Title	ASTM Requirement	Method of Test
Tensile Strength (Die “C”)	2500 psi. min.	D 412
Ultimate Elongation (Die “C”)	450 percent, min.	D 412
Shore Durometer Hardness	60-70	D 2240
Specific Gravity (Sec. 17)	1.15 + 0.03	D 297
Water Absorption (% by Wt.)	5 percent, max.	D 570
Tensile Strength after accelerated Aging, oxygen-pressure method	80 percent, min.	D 572

a. Polyvinylchloride Waterstop

i. This waterstop shall be extruded from an elastomeric plastic material. The material shall be a plastic compound, the basic resin of which shall be polyvinylchloride. The compound shall contain any additional resins, plasticizers, stabilizers, or other materials needed to insure that when the material is compounded it will meet the performance requirements of this Specification. No reclaimed polyvinylchloride shall be used.

Title	ASTM Requirement	Method of Test
Tensile Strength (Die “C”)		
Sheet Material	2,000 psi	D 412
Finished Waterstop	1,700 psi	D 412
Ultimate Elongation (Die “C”)		
Sheet Material	350% Min.	D 412
Finished Waterstop	300% Min.	D 412
Stiffness in Flexure	750 psi Min.	D 747
Accelerated Extraction		CRD C 572
Tensile Strength (Die “C”)	1,750 psi	D 412
Elongation (Die “C”)	300%	D 412
Effect of Alkali (After 7 Days)		
Change in Weight	-0.1 to +0.25%	
Change in Hardness, Shore Durometer	+ or – 5%	
Low Temperature Brittleness	-35^{o}	D 746
Specific Gravity	1.3	D 792

ii. For polyvinylchloride waterstops, the supplier shall submit a certificate stating that all of the performance requirements specified for the sheet material under Polyvinylchloride Waterstops have been complied with. Field splices for Polyvinylchloride waterstops shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer’s recommendations. Waterstops shall be manufactured with an integral cross-section which shall be uniform within plus or minus 1/8 inch in width, and the web thickness or bulb diameter within plus 1/16 inch and minus 1/32 inch.

iii. The Subcontractor shall furnish the Purchaser at this request and at no cost to the Purchaser a certified test report from an approved laboratory covering each lot or

unit of finished waterstops. These test reports shall contain the numerical laboratory test data of the required test.

B. Epoxy Resin Systems

1. Two Component epoxy resin systems shall conform to the requirements of the appropriate class designation of AASHTO M 200, M 234, M 235, unless otherwise designated on the Plans or in the Contract. The appropriate class designation is determined by the proposed use of the material.

2. Requirements for Specific Uses:

a. Bonding fresh concrete to cured concrete.
Requirements: The material shall meet the compositional specification of AASHTO M 235, Class I and applicable requirements of the Class III performance specification.

b. Bonding cured concrete to cured concrete.
Requirements: The material shall meet the compositional specification of AASHTO M 235, Class II and the applicable requirements of the Class III performance specification.

c. Binder in epoxy resin concrete and mortar for repairing spalls and other defects in concrete.
Requirements: The material shall meet the compositional specification of AASHTO M 235, Class II and the applicable requirements of the Class III performance specification.

C. Bar Reinforcement

1. Unless otherwise specified, all steel reinforcement for concrete shall be billet steel bars conforming to the requirements of ASTM A 615.

D. Dowel Bars

1. Dowel bars shall be plain and shall conform to the requirements of ASTM A 306, Grade 55, 60, 65, or 70.

E. Welded Wire Fabric

1. Fabric for reinforcement shall conform to ASTM A 185, or as indicated on the Plans, and shall be supplied in mats of the size, design and weight shown on the Plans.

1.02 EQUIPMENT

A. Equipment and tools necessary for handling materials and performing all parts of the Work shall be subject to approval by the Purchaser as to design, capacity, and mechanical condition. Equipment shall be on hand sufficiently ahead of the start of construction operations to be examined and approved. The equipment and organization shall be of sufficient capacity to accomplish the maximum continuous concrete placement, as governed by the construction joints shown on the Plans or as directed by the Purchaser.

B. The requirements for batching plant and mixers shall be as prescribed in Specification Section 03 05 00.

C. Ample and satisfactory equipment for conveying concrete from the mixer to final position in the forms shall be provided. Closed chutes or pipes shall be used when concrete is to be dumped

or dropped for a distance greater than 5 feet. Where steep slopes are required, the chutes shall be equipped with baffle boards or shall be in short lengths that will enable the direction of movement to be reversed.

D. Vibrators shall be of an approved type and design and shall operate under load at a rate as recommended by the manufacturer and approved by the Purchaser.

PART 3 EXECUTION

3.01 FORMS

A. Construction

1. Forms shall be mortar-tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other stresses incidental to the construction operations, including vibration. Forms shall be so constructed and maintained as to prevent the opening of joints due to shrinkage of the lumber.

2. The forms shall be built true to line and grade and shall be held in place by means of studs or uprights, and waling, which shall be sufficiently and substantially braced and tied.

3. All forms and studding shall be cut off and capped with not less than a 2 inch by 4 inch piece so that the top of the cap will be at the elevation of the finished exposed surface of the concrete.

4. All edges shall be chamfered with ¾ inch material, unless otherwise specified. All chamfer strips shall be straight, of uniform width, and dressed.

5. Wood devices of any kind used to separate forms shall be removed before placing concrete within 4 inches of such devices.

B. Form Lumber

1. Form lumber for all exposed concrete surfaces shall be dressed at least on one side and two edges and shall be so constructed as to produce mortar-tight joints and smooth, even concrete surfaces.

2. Plywood forms, or forms face-lined with plywood, masonite, or other approved similar material may be used, provided the plywood forms and form linings are substantial, of uniform thickness, and are mortar-tight when in position.

C. Metal Ties

1. Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least one inch from the face without injury to the concrete. In case wire ties are permitted, the wires shall be cut back at least ¼ inch from the surface of the concrete, and the surface left sound, smooth, even, and uniform in color.

D. Walls

1. Sufficient openings shall be provided at intervals along the bottom of wall forms to permit thorough cleaning prior to concrete placement. Such openings shall be closed before placing concrete in the forms.

E. Surface Treatment

1. Prior to placing reinforcement, all forms shall be treated to prevent the adherence of concrete. Forms not provided with a special treatment shall be treated with an approved oil. Any material that will adhere to or discolor the concrete shall not be used.

F. Metal Forms

1. The specifications for forms, as regards design, mortar tightness, filleted corner, beveled projections, bracing, alignment, removal, and reuse and oiling apply to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt and rivet heads shall be countersunk on the face forming the concrete surface. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or do not line up properly shall not be used. Care shall be exercised to keep metal forms free from rust, grease, or other foreign matter.

2. When the Subcontractor wishes to utilize a special forming system not specifically authorized in this Specification, he shall submit his design and calculation to the Purchaser for review and approval.

3.02 FALSEWORK

A. The falsework used to support the forms and concrete for concrete structures shall be supported on sills resting on rigid foundations composed of piles driven until the bearing capacity of each pile is sufficient to support the load to which it will be subjected, or earth-borne footings as hereinafter provided.

B. Earth-borne footings will be permitted only when, in the opinion of the Purchaser, the soil can adequately support the superimposed loads and the following conditions are met:

1. Spread footings will only be permitted on stable ground, capable of supporting the superimposed load.

2. The site is graded and so maintained to prohibit ponding of water or erosion of soil in the proximity of the spread footings.

3. The falsework system shall be designed and constructed to preclude exceeding the bearing capacity of the soil but in no case shall exceed 3,000 pounds per square foot.

4. The footings shall be designed and constructed to carry the superimposed loads.

5. All footings shall be constructed on a level plane.

C. The falsework shall be designed and constructed to support the required loading without distortion or settlement of the forms.

D. The Subcontractor shall place “tell-tales” for observation of the amount of falsework settlement at locations designated by the Purchaser.

E. The Purchaser may require the Subcontractor to submit detailed falsework plans, together with a soils report, design calculations or any other information necessary for a thorough review. The Subcontractor is totally responsible for the design and construction of the falsework system and shall repair, or remove and replace, as directed and at his expense, any concrete, other material or portions of the structure which are damaged or destroyed due to failure of the falsework.

3.03 REINFORCEMENT

A. All reinforcement shall consist of deformed steel bars, unless otherwise indicated or directed. Deformed steel bars shall have a net area at all sections equivalent to that of plain round or square bars of the corresponding nominal size.

B. Structural steel shapes shall conform strictly to the shapes indicated or required.

C. Steel wire fabric may be furnished in rolls or sheets.

D. Reinforcing steel shall be stored above the ground surface upon platforms, skids or other supports located without the scope of the active construction operations and shall be protected at all times from injury and damage. All brush and weeds shall be removed from the area immediately prior to storing reinforcing steel thereon.

E. Reinforcing steel, where indicated, shall be accurately bent, without heating, to the forms and dimensions indicated on the Plans. Minimum bend diameters shall be in accordance with the requirements of the American Concrete Institute. Unless otherwise indicated, all bends shall be in one plane. Bars of ¾ inch or less which have only hooks or a single bend may be bent in the field, provided satisfactory equipment for proper and accurate work is used and provided the bending is accomplished true to form and dimensions without damage to the bars. All other bending shall be done in the shop before shipment.

F. Substitution of bars of different sizes from those indicated on the Plans may only be made with the written permission of the Purchaser. If substitution is permitted, the following shall apply:

1. The total area of steel in any one linear foot in each direction shall not be reduced.

2. For cast-in-place concrete the clear distance between parallel bars in a layer shall not be less than 1.5 bar diameters, 1.5 times the maximum size of the coarse aggregate, nor 1-1/2 inches.

3. Where positive or negative reinforcement is placed in two or more layers, bars in the upper layers shall be placed directly above those in the bottom layer with the clear distance between layers not less than 1 inch.

4. Clear distance limitation between bars shall also apply to the clear distance between a contact lap splice and adjacent splices or bars.

5. Groups of parallel reinforcing bars bundled in contact to act as a unit shall be limited to 4 in any one bundle. Bars larger than #11 shall be limited to two in any one bundle in beams. Bundled bars shall be located within stirrups or ties. Individual bars in a bundle cut off within the span of a member shall terminate at different points with at least 40 bar diameters stagger. Where spacing limitations are based on bar diameter, a unit of bundled bars shall be treated as a single bar of a diameter derived from the equivalent total area.

6. In walls and slabs, the primary flexural reinforcement shall be spaced not farther apart than 1.5 times the wall or slab thickness, nor 18 inches.

G. All reinforcement shall be furnished in the full lengths shown on the Plans, unless otherwise approved in writing by the Purchaser. No splices shall be made unless indicated on the Plans or authorized by the Purchaser. Splices shall be so arranged and manipulated as to provide a minimum of 2 inches net clearance between the splices and the surface of the complete concrete work, unless otherwise indicated or directed. Splices of tension reinforcement at points of maximum stress shall be avoided. The members at all splices shall be rigidly clamped

by means of at least two approved metal clips located approximately 3 inches from the ends of the bars and bolted around them or securely wired in a manner satisfactory to the Purchaser.

H. Steel shapes shall be spliced only as indicated on the Plans.

I. Steel fabric shall be spliced by overlapping of the sheets by not less than 12 inches; by matching at least three transverse member; and by securely wiring the overlapped sections in a manner satisfactory to the Purchaser.

J. All reinforcing steel before being placed shall be thoroughly cleaned of mill scale, rust, dirt, paint, oil, or other foreign substances or coating of any character that will reduce the bond. If reinforcement which has been placed becomes dirty, rusty, or spattered with mortar which dries before concrete is placed around it, such reinforcement, or part affected, shall be thoroughly cleaned before being covered with concrete.

K. Reinforcement shall be accurately placed and firmly held in position as indicated on the Plans. Steel bars shall be securely fastened together with metal clips or wire at each intersection, except where spacing is less than on 1 foot in each direction then alternate intersections shall be fastened. All reinforcing steel shall be securely spaced from the forms and between adjacent reinforcement by means of precast mortar blocks, metal spacers or other approved devices or methods, and where possible, all spacer devices shall be so arranged that their use cannot be detected in the completed structure. Spacer blocks shall be cast of mortar mixed in the same proportions as that in the concrete mixture and shall not have a length or width greater than the depth required for proper spacing from the forms or between adjacent reinforcement. The use of gravel, concrete, brick, or wooden blocks is prohibited.

L. All the reinforcing steel necessary for a section of a concrete structure shall be accurately and securely placed and the placement approved by the Purchaser before any concrete is deposited in the section, and care shall be observed not to disturb it during the placing of the concrete.

M. All dimensions relating to reinforcing bars are to the centers of the bars, unless otherwise indicated.

N. Tolerances for bending and cutting during fabrication shall be in accordance with the “Manual of Standard Practice” published by the Concrete Reinforcing Steel Institute.

3.04 DRAINAGE AND WEEP HOLES

A. Drainage openings and weep holes shall be constructed using materials in the manner and at the locations shown on the Plans or established by the Purchaser. Ports or vents for equalizing hydrostatic pressure, when required, shall be placed as directed.

3.05 PLACING PIPES, CONDUITS, ANCHORS, CASTING, AND OTHER APPURTENANCES

A. Pipes, conduits, anchors, castings, bolts, plates, grillage, and other appurtenances which are necessary or desirable to be placed in the concrete of a structure, whether indicated on the Plans or not, shall be placed by the Subcontractor during construction, as directed.

B. No compensation will be allowed for placing such pipes, conduits, and other appurtenances, except that no deductions will be made for the volume of concrete displaced by those items.

3.06 EXPANSION JOINTS

A. Expansion devices shall be as indicated on the Plans. The devices shall be securely anchored in correct position. All sliding surfaces shall be true and smooth and shall form complete contact throughout. Movement shall not be impeded by the concrete in which they are embedded.

B. Unless otherwise provided, where portions of concrete bridge superstructure rest on the substructure, the contact area shall be separated by at least two layers of three-ply bituminous-saturated paper.

C. Open joints shall be constructed using forms which will permit removal without injury to the concrete. After removal of the forms, the joints shall be cleaned thoroughly. Filled joints shall be constructed with pre-molded filler, unless otherwise indicated. Joints requiring a sealant shall be thoroughly cleaned and sealed with one of the specified joint sealing materials before the structure is opened to traffic. Edges of open and filled joints shall be chamfered or edged, as directed. Mortised joints shall be constructed as shown on the Plans or as directed.

3.07 PLACING CONCRETE

A. General

1. Concrete shall not be placed until forms and reinforcing steel have been checked and approved. The forms shall be clean of all debris and kept wet immediately before concrete is placed. The method and sequence of placing concrete shall be approved by the Purchaser. Unless otherwise permitted, all concrete shall be placed in daylight, and the placing of concrete in any portion of the structure shall not be started unless it can be entirely completed in daylight. When the placing of concrete is permitted during other than daylight hours, an adequate and approved artificial lighting system shall be provided and operated.

2. All concrete shall be thoroughly worked during the placing by means of tools of approved type. The working shall be such as to force all coarse aggregate from the surface and to bring mortar against the forms to produce a smooth finish, substantially free from water and air pockets or honeycomb.

3. If the forms show bulging or settlement while concrete is being placed, the placing shall be stopped until correction has been made.

4. T-beam girders, slabs, arch rings, and all horizontal sections of bridges except curbs and sidewalks shall be constructed monolithically and continuously, unless otherwise permitted. Curbs and sidewalks shall be constructed after the bridge deck is completed, unless otherwise indicated on the Plans.

5. After initial set and prior to final set of the concrete, the forms shall not be jarred, and no strain shall be placed on the ends of the projecting reinforcement. Piles shall not be driven closer than 20 feet to footings less than 7 days old nor to foundations supporting concrete less than 7 days old.

B. Railings and Curbing

1. When constructing curb, careful attention shall be given to the installation of railing steel or anchoring devices.

2. Concrete railings shall not be constructed on any structure until the falsework has been struck.

C. Chutes and Troughs

1. Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement.

2. All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. The water used for flushing shall be discharged clear of the concrete already in place.

3. Care shall be taken to fill each part of the form by depositing the concrete as near final position as possible. The coarse aggregate shall be worked back from the forms and around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement.

D. Vibrating

1. Unless otherwise directed, the concrete shall be compacted with suitable mechanical vibrators operating within the concrete. When required, vibrating shall be supplemented by hand spading with suitable tools to assure proper and adequate compaction.

2. Vibrators shall be so manipulated as to work the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. Vibrators shall not be used as a means to cause concrete to flow or run into position in lieu of placing. The vibration at any point shall be of sufficient duration to accomplish compaction but shall not be prolonged to the point where segregation occurs.

3. At least on additional standby vibrating unit shall be available for all individual pours in excess of 10 cubic yards.

E. Joints

1. Feather-edge construction joints will not be permitted. Transverse or longitudinal joints through spans will not be permitted, except where specified.

2. In no case shall the concreting of any section or layer be stopped or temporarily discontinued within 18 inches of any finished surface, unless the details of the structure provide for a coping having a thickness of less than 18 inches, in which case, at the option of the Purchaser, the construction joint may be made at the underside of the coping.

3. Layers completing a day’s work or placed just prior to temporarily discontinuing operations shall be cleaned of all laitance or other objectionable material as soon as the surface has become sufficiently firm to retain its form.

3.08 BONDING CONSTRUCTION JOINTS

A. Where dowels, reinforcing bars, or other adequate ties are not indicated on the Plans, keys of a directed size shall be made by constructing projections above the concrete and monolithically with the concrete.

B. In resuming work, the forms shall be drawn tightly against the face of the concrete. The entire surface of the concrete to be bonded shall be cleaned thoroughly and roughened with a steel tool. In addition, if directed, the surface to be bonded shall be cleaned and roughened by sandblasting. The surface shall then be soaked with clean water, after which concreting may proceed.

3.09 REMOVAL OF FORMS AND FALSEWORK.

A. Forms for ornamental work, railings, parapets, columns, and vertical surfaces that do not carry loads shall be removed in from 12 to 48 hours, unless otherwise directed by the Purchaser. In cold, damp, or freezing weather, all vertical forms shall remain in place until the concrete has set sufficiently to withstand damage when the forms are removed. In removing forms, care shall be exercised not to mar the surface of the concrete nor to subject it to any undue pressure.

B. Projecting wires or other metal devices used for holding forms in place and which pass through the body of the concrete shall be removed or cut as specified in Specification Section 03310 Paragraph 3.01.A, and the holes or depressions thus made and all other holes, depressions, and small voids which show upon the removal of the forms shall be filled with cement mortar mixed in the same proportions as that which was used in the body of the concrete which is being repaired.

C. Falsework and supports under slab or girder spans, any length, may be released and removed when representative specimens of the concrete in the spans, cured by the methods and in the manner the concrete which the test specimens represent is cured, attain a compressive strength of 3,000 pounds per square inch. In addition to the above requirement, the concrete shall have been placed a minimum of 10 days, not counting the days of 24 hours each in which the temperature falls below 40^{o} F., or 21 calendar days, whichever occurs first.

D. For continuous concrete girder or slab units, any length, the falsework and supports shall not be released or removed from any span in the continuous unit until the concrete in all spans in the unit has been placed a sufficient length of time to meet all requirements for the removal of falsework and supports as set forth above.

E. Forms supporting bridge decks between girders and outside curb overhangs may be removed after seven days.

3.10 DEFECTIVE CONCRETE

A. Any defective concrete discovered after the forms have been removed shall be removed immediately and replaced. If the surface of the concrete is bulged, uneven, or shows honeycombing which cannot be repaired satisfactorily, the entire section shall be removed and replaced.

B. Concrete having a 28 day strength of less than the minimum specified shall be removed and disposed of by the Subcontractor, at his expense, unless specifically authorized by the Purchaser, in writing, to remain in place. The removal shall be in such a manner as will not cause damage to the remaining concrete or to other structural units or other facilities and property.

3.11 FINISHING CONCRETE SURFACES

A. Unless otherwise authorized, the surface of the concrete shall be finished immediately after form removal.

B. All concrete surfaces shall be given a Class 1 finish. The following surfaces of all structures shall be given a Class 2 Finish: roadway face and top of curb, vertical outside face of curb overhang or sidewalk slab, bottom surface of slab overhang, bridge railings, barrier railings, all vertical surfaces of the superstructure of dual bridges exposed to view from either structure, and all surfaces of retaining walls, wingwalls, and end walls which are visible from passing vehicles.

1. Class 1, Ordinary Surface Finish

a. Immediately following the removal of the forms, all fins and irregular projections shall be removed from all surfaces which are to be exposed or waterproofed. On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges, and other defects, shall be thoroughly cleaned, saturated with water, and carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the Class of the concrete being finished. Mortar used in pointing shall not be more than 30 minutes old. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

b. All surfaces which cannot be repaired to the satisfaction of the Purchaser shall be "rubbed" as specified for a Class 2 finish.

2. Class 2, Rubbed Finish.

a. After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work, the concrete shall be kept thoroughly saturated with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing to thoroughly set. Surfaces to be finished shall be rubbed with a wetted wooden block or a medium coarse carborundum stone. The carborundum stone shall not be used until the concrete has hardened to the state where the sand will grind, rather than ravel or roll. Rubbing shall be continued until all form marks, projections, and irregularities have been removed; all voids filled; and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place. A brush finish or painting with grout will not be permitted.

b. After all concrete above the surface being finished has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color.

c. After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder, and objectionable marks.

3. Class 3, Float Finish

a. This finish, for unformed surfaces, except slab surfaces for pavements or bases, shall be achieved by placing an excess of material in the form and removing or striking off the excess with a template, forcing the coarse aggregate below the mortar surface. Creation of concave surfaces shall be avoided after the concrete has been struck off, the surface shall be thoroughly worked and floated with a suitable floating tool of wood, canvas, or cork. Before the finish has set, the surface cement film shall be removed with a fine brush in order to have a fine-grained, smooth but sanded texture.

3.12 FINISHING SLAB SURFACES FOR PAVEMENTS OR BASES.

A. Bridge floors or top slabs of structures serving as finished pavements or bases shall be finished either by hand methods or approved mechanical finishing machines.

B. When the hand method is used, the bridge floors or slabs shall be struck off with a screed which is parallel to the centerline of the roadway, resting on bulkheads or screed strips cut or set to the required cross-section of the roadway. This screed shall be so constructed as to have sufficient strength to retain its shape and that the cutting edge may be adjusted to conform to the profile of the roadway. Screeds shall be of sufficient length to finish the full length of spans 40 feet or less in length. Spans over 40 feet in length shall be finished in two or more

sections, but no section shall be less than 20 feet in length. Screed strips or headers shall be accurately set to the4 specified grades, checked, and adjusted as necessary prior to the final screeding operation. The screed shall be worked back and forth over the surface until the proper profile and cross-section is obtained.

C. When mechanical finishing machines are used, they shall be approved power driven machines, traveling on rails adjusted to conform to the profile of the roadway. The machines shall be equipped with oscillating or vibrating transverse or longitudinal screeds that may be adjusted to conform to the profile or the required cross-section of the roadway. The screeds shall have sufficient strength to retain their shape after adjustment. The finishing machine shall go over each area of the bridge floor as many times as is required to obtain the required profile and cross-section.

D. Regardless of the method of finishing, the Subcontractor shall maintain a minimum rate of placement of 20 linear feet of bridge deck per hour when concrete is placed in a longitudinal section.

E. After finishing as described above, the surface shall be checked with a 12 foot straightedge and shall show no deviation is excess of 1/8 inch from the testing edge of the straightedge when placed parallel to the centerline. Deviations in excess of this requirement shall be corrected before the concrete sets.

F. The surface shall be finished by dragging a seamless strip of damp burlap over the full width of the surface. The burlap drag shall consist of sufficient layers of burlap to slightly groove the surface and shall be moved forward with minimum bow of the lead edge. The drag shall be kept damp, clean, and free of particles of hardened concrete. A light broom or brush herring bone finish that leaves a texture similar to that obtained by the burlap drag may be used when permitted by the Purchaser. For bases, the surface shall be finished by grooving lightly with a wire broom at an angle of 60^{o} with the centerline. All strokes shall begin at the center and end at the edge. After the slab has been finished by the burlap drag, surfaces which will become traffic lanes shall be textured by the formation of transverse grooves. The grooves shall be formed in the surface at an appropriate time during the stiffening of the concrete, so that in the hardened concrete the grooves will be between 0.09 inch and 0.13 inch in width; between 0.12 inch to 0.19 inch in depth; and spaced at random intervals between 0.3 inch and 1.0 inch. The grooves shall terminate approximately 18 inches from curbs, parapets, barrier walls, and other vertical walls. The grooves shall be relatively smooth and uniform; shall be formed without tearing the surface and without bringing pieces of coarse aggregate to the top of the surface; and shall be formed to drain transversely. All areas which do not conform to these requirements shall be corrected at the Subcontractor’s expense by approved methods.

G. As soon as the surface has set sufficiently to withstand damage when walking on it and not later than the morning following the placing of the concrete, it shall be straightedged with the 12 foot straightedge and all variations exceeding 1/8 inch shall be plainly marked. The Subcontractor shall correct a seal such variations in the same manner as specified for Portland Cement Concrete Pavement.

3.13 CURING CONCRETE

A. All concrete surfaces, except those surfaces protected by forms that remain in place seven days or longer as required under the provisions of Specification Section 03310 Paragraph 3.09, “Removal of Forms and Falsework”, shall be cured as specified below. Curing shall begin as soon as the concrete has hardened sufficiently to withstand surface damage to unformed surfaces and immediately after the forms have been removed from formed surfaces.

B. When the temperature is expected to fall below 35^{O} F., the concrete shall be protected in accordance with the provisions of Specification Section 03310 Paragraph 3.14.

C. The initial curing period for concrete surfaces shall be by the “Water Method” for a period of not less than 24 hours, or until the concrete surfaces have been prepared for the application of curing compound, in accordance with the provisions under B below. During the initial curing period, the concrete shall be protected from the sun by burlap mats or other approved materials and kept completely and continuously moist.

D. The “Water Method” and membrane-forming compound method of curing will be required for all bridge decks, and on all concrete slabs when the temperature exceeds 90^{O} F during placement.

1. Water Method

a. All concrete slabs shall be covered immediately with material suitable for use with the water cure and kept thoroughly wet for at least 120 hours from the beginning of the initial curing period. All surfaces other than slabs shall be protected from the sun and shall be kept wet for a period of at least 72 hours from the beginning of the initial curing period. Curbs, walls, handrails, and other surfaces requiring a Class 2 finish may have the covering temporarily removed for finishing, but the covering shall be restored as soon as possible.

2. Membrane-Forming Compound Method

a. All surfaces shall be given the required surface finish prior to application of the curing compound. Prior to the application of curing compound, the surface shall be kept moist.

b. The rate of application of curing compound shall be as recommended by the manufacturer but shall not be less than one gallon for 150 square feet of concrete surface. The curing compound shall be applied, under pressure, immediately after completion of the initial curing period or acceptance of the concrete finish. If the surface is dry, the concrete shall be thoroughly wet with water and the curing compound applied just as the surface film of water disappears. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. If the application of the compound results in a streaked or blotchy appearance, the method shall be stopped and water curing, as set out above, applied until the cause of the defective appearance is corrected. The coating shall be protected against marring for a period of seven days from date of application. Any coating marred or otherwise disturbed within the seven day period shall be replaced at once.

3.14 PROTECTION OF CONCRETE IN COLD WEATHER

A. Concrete shall be protected in cold weather a specified in Specification Section 03050.

3.15 WATERPROOFING AND WATERSTOPS

A. Waterproofing shall be applied as indicated in the Division 2 Specifications.

B. Metallic or nonmetallic waterstops, as specified, shall be installed in accordance with the details shown on the Plans and in conformity with the requirements of these Specifications.

C. Metallic waterstops shall be spliced, welded or soldered, as necessary, to form continuous, watertight joints.

D. Nonmetallic waterstops shall be installed in continuous strips without splices, except that splices will be permitted at changes in direction when necessary to avoid buckling or distortion

of the web or flange. All splices of nonmetallic waterstops shall be performed in accordance with the manufacturer's recommendations and in the case of polyvinylchloride waterstops, the heat used shall be sufficient to melt but not char the plastic.

E. Adequate provisions shall be made to support the waterstops during the progress of work and to insure their proper embedment in the concrete. The concrete shall be thoroughly worked in the vicinity of the joints to insure maximum density and imperviousness. Forms shall be so designed that they can be removed without damaging the waterstops. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from mechanical damage.

PART 4 MEASUREMENT & PAYMENT

4.01 MEASUREMENT

A. All concrete will be measured for payment as stipulated under the Specification Section specifying each individual type of construction.

B. No allowance will be made for furnishing the material and the construction of drainage openings and weep holes as indicated or as directed, provided such openings are 6 inches in diameter or less, except that no deduction will be made for such openings in the computation of concrete quantities. Allowance will be made for other openings as indicated.

C. No allowance will be made for additional cement used in depositing concrete underwater; for use of calcium chloride or chemical additives; for fillers, sealer, and tar paper used in expansion joints; for dowels or other materials used in bonding construction joints; for waterstops; and for painting metals.

D. No allowance will be made for concrete placed below the foundation elevation shown on the Plans or as directed by the Purchaser.

E. No additional compensation will be made for high-early-strength concrete substituted by the Subcontractor.

4.02 PAYMENT

A. All concrete will be paid for as stipulated under the Specification Section specifying each individual type of construction.

END OF SECTION 03310

2497 HANWOOD AVENUE

CITY OF MEMPHIS

SARP10 PROGRAM

DECEMBER 1, 2021
CONSTRUCTION DOCUMENTS

PREPARED BY: PICKERING FIRM, INC.

4296 Hanwood Ave – Replaces Sections 15010, 15150, and 15160

PERFORMANCE SPECIFICATION
SUBMERSIBLE PUMPS CONTROLS & ACCESSORIES

1.0 GENERAL DESCRIPTION

1.01 Scope

A. This section includes equipment for one duplex submersible pump station to be supplied with integral electric motors, discharge elbows, guide bar brackets, access cover and valves, and electrical control panel assembly, and other miscellaneous installation accessories. All equipment shall be supplied by a single source supplier that adheres to the quality standards established and expressly named in this specification.

B. Acceptable manufacturers are those who meet this specification in its entirety and that can demonstrate compliance with these specifications through the submittal process outlined in section 2.04 such that no exceptions or deviations are noted (See Paragraph 2.04 Submittal). The System Supplier, for all equipment approved for this project shall meet or exceed all performance, material, service, and warranty requirements of this specification.

C. The Bidder shall be responsible for supplying the equipment specified herein to meet or exceed these specifications as obtained from the System Supplier for this project. The System Supplier shall be an Authorized Distributor of the proposed products and shall be capable of servicing the products with repair service and parts availability within 50 miles of the City of Memphis. The responsive System Supplier shall routinely stock complete pumps, controls and parts to repair those units in their own facility. All equipment approved for this project shall meet or exceed all performance, service, and warranty requirements of this

1.02 RELATED REQUIREMENTS

A. Bid Form
B. General Conditions
C. Shop Drawings
D. Painting
E. Electrical

2.0 QUALITY ASSURANCE

2.01 General

The pumps shall be suitable for pumping raw sewage and shall be designed and fully guaranteed for this use. The fluid temperature range shall be from 40 degrees to 104 degrees F.

2.02 Standards

The test code of the American Hydraulic Institute for testing pumps and sound engineering practice shall be used. Where required, all pump performance documentation, including flow/head curves, shall adhere to the Hydraulic Institute Standards and shall allow no negative tolerance on flow, head, hydraulic efficiency or any other criteria deemed by the Engineer to be necessary to evaluate pumping system performance.

2.03 Environmental Conditions

All equipment as specified herein shall be so supplied with respect to environmental conditions at the jobsite.

2.04 Submittals

Complete equipment and control submittals, complete assembly, foundation support, and installation drawings, together with detailed specifications and data covering pumps, motors, material used, parts, devices and other accessories forming a part of the equipment furnished shall be submitted for approval in accordance with the procedure set forth in the General Conditions.

Data and specifications for the equipment shall include, but shall not be limited to the following:

A. Setting plans. Setting plans shall include:

1. Anchor bolt layout
2. Anchor bolt dimensions.
3. Outline dimensions and weights of pumps, bases, motors, and control enclosures, etc.

B. Pumps. Data and drawings shall include:

1. Manufacturer, type and model number.
2. Assembly drawing, nomenclature and material list, O & M manual, and parts list.
3. Type, manufacturer, model numbers, location and spacing of bearings.
4. Impeller type, diameter, thru-let dimensions, sphere size, number of vanes and identification number.
5. Complete motor performance data including: rating, voltage/phase/frequency; design type; service factor; insulation class; motor pole number; actual rotation speed when combined with the specified pumps; current, power factor and active input power (KW) as a continuous function of shaft power from no load to at least 115 percent load; start (max. Inrush) current; locked rotor current; NEC code letter; and motor torque as a continuous function through the motor start cycle from no rotation to synchronous speed.
6. Complete performance test curve(s) showing full range (shutoff to run-out) head

vs. Capacity, NPSHR, hydraulic efficiency, motor active (KW) input power, motor total (KVA) input power (based on measured current and voltage), and shaft power (BHP). See Sec. 3.01 Shop Tests.

7. Location and description of Service Centers and spare parts stock.
8. Warranty for the proposed equipment.

C. Controls. Complete Schematics and Documentation shall include:

1. Panel layout drawings that show accurate dimensions, location of components, and proper connection of terminations with complete schematics of the proposed equipment.
2. Cut sheets on all items to be provided.
3. Operation manuals on VFDs or PLCs to be provided.

The manufacturer shall indicate, by arrows to points on the Q/H curves, limits recommended for stable operation, between which the pumps are to be operated to prevent surging, cavitation, and vibration. The stable operating range shall be as large as possible, and shall be based on actual hydraulic and mechanical characteristics of the units and shall meet the hydraulic performance requirements of the proposed system.

3.0 TESTING

3.01 Shop Tests

Pumps and Motors. Each pump and motor shall be performance tested as specified hereinafter; all pumps shall be tested with motor cables to be supplied with the pumps.

Each pump shall be tested for performance at the factory to determine the head vs. Capacity, motor total electrical power draw (KVA), and motor active electrical power draw (KW) for the full speed at which the pumps are specified and shown on a performance test curve. The motor and cable on each pump shall be tested for moisture content or insulation defects. After the test, the pump cable end shall be fitted with a shrink-fit rubber boot to protect it from moisture or water.

3.02 Acceptance tests

Acceptance tests shall be run to demonstrate that the pumping units, motors and control system meet the following requirements:

A. The pumping units operate as specified without excessive noise, cavitation, vibration, and without overheating of the bearings.

B. All automatic and manual controls function in accordance with the specified requirements.

C. All drive equipment operates without being overloaded.

4.0 PERFORMANCE

Submersible pumps shall meet the following performance requirements:

Item (Units)	**60 Hertz Operation**
Primary Duty Point (GPM/ft.)	95 GPM@ 30' TDH
Minimum Shutoff Head (ft.)	36 Ft.
Maximum Specific Energy at Primary Duty Point (KWHr/MG)	370 KWHr/MG
Min Motor Rating (HP) at 40 degrees C	3 HP @ 40° C
Maximum NPSHre (ft) for AOR	16 Feet
Voltage/Cycle/Phase	230/60Hz/ 3Phase
Motor Design Type	NEMA Class B, NEMA MG1, Part 31 Rated
Motor Service Factor	Greater than 1.10
Motor Insulation Rating	Class H
Maximum Rated Current (A)	8.7 Amps
Minimum Pump Discharge Connection Size (inches)	4"

5.0 EQUIPMENT

5.01 Pump Design (Wet Well Mounted)

The pump shall be capable of handling raw, unscreened sewage. The discharge elbow shall be permanently installed in the wet well along with the discharge piping. The pumps shall be automatically connected to the discharge connection elbow when lowered into place. Pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be removed for the purpose and no need for personnel to enter the pump well. Sealing of the pumping unit to the discharge elbow shall be accomplished by a simple linear downward motion of the pumps with the entire weight of the pumping units guided to and pressed tightly against the discharge elbow with a metal to metal watertight contact. Sealing of the discharge interface by means of a diaphragm, O-ring or other device will not be acceptable. No portion of the pump shall bear directly on the floor of the sump, and there shall be no more than one 90 degree bend allowed between the volute discharge flange and sump piping. Guide bars, which shall steer the pump into proper contact with the discharge elbow shall be non-adjustable and shall not bear the weight of the pump.

5.02 Pump Construction

A. Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel or brass construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating. The coating shall be a two-pack oxyrane ester Duasolid 50. The total layer thickness should be at least 120 microns. Zink dust primer shall not be used.

Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.

Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

5.03 Cable Seal

The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

5.04 Cooling System

Motors are sufficiently cooled by the surrounding environment or pumped media. A water jacket is not required.

5.05 Mechanical Seal

Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in an lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary tungsten-carbide ring and one positively driven rotating ceramic ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary ceramic seal ring and one positively driven rotating carbon seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing. The position of both mechanical seals shall depend on the shaft. Mounting of the lower mechanical seal on the impeller hub will not be acceptable. For special applications, other seal face materials shall be available.

The following seal types shall not be considered acceptable nor equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.

Each pump shall be provided with an lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate dry without damage while pumping under load.

Seal lubricant shall be FDA Approved, nontoxic.

5.06 Shaft

Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The shaft shall be AISI type 431 stainless steel.

If a shaft material of lower quality than 431 stainless steel is used, a shaft sleeve of 431 stainless steel is used to protect the shaft material. However, shaft sleeves only protect the shaft around the lower mechanical seal. No protection is provided in the oil housing and above. Therefore, the use of stainless steel sleeves will not be considered equal to stainless steel shafts.

5.07 Impeller

The impeller and volute insert ring shall be cast of ASTM A532, ALLOY IIIA Hi-Chrome Iron, dynamically balanced, semi-open, multi-vane, back-swept, non-clog design. The impeller vane leading edges shall be mechanically self-cleaned upon each rotation as they pass across a spiral groove located on a replaceable insert ring.

The screw shape of the impeller inlet shall provide an inducing effect for the handling of sludge and rag-laden wastewater. The impeller shall be capable of momentarily moving axially upwards a distance of 15mm/0.6-in. to allow larger debris to pass through and immediately return to normal operating position.

5.08 Bearings

The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Sleeve or single row lower bearings are not acceptable.

5.09 Motor and Protection Devices

The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180oC (356oF). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31.The stator shall be heat-

shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of 40°C (104°F) and capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125°C (260°F) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board, shall be hermetically sealed from the motor by an elastomer compression seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. The motor and the pump shall be produced by the same manufacturer.

The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.

The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.

The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 125°C (260°F) the thermal switches shall open, stop the motor and activate an alarm.

A leakage sensor shall be used on pumps of 3 Hp and above to detect water in the stator chamber. The Float Leakage Sensor (FLS) is a small float switch used to detect the presence of water in the stator chamber. When activated, the FLS will send an alarm and, if desired, stop the motor. Use of voltage sensitive solid state sensors and trip temperature above 125°C (260°F) shall not be allowed.

The thermal switches and FLS shall be connected to a Mini CAS (Control and Status) monitoring unit. The Mini CAS is designed to be mounted in any control panel.

5.10 Guide Bars and Brackets

Two AISI 304SS Schedule 40 guide bars and brackets shall be provided for each pump

for the purpose of guiding the pump unit in raising and lowering. The guide bars shall not support any portion of the weight of the pump. The lower guide bar holders shall be integral with the discharge elbow. Guide cables shall not be considered equal to guide bars and will not be accepted. The pump unit shall be guided on the bars by a guide bracket which shall be an integral part of the pump.

5.11 Lifting Chain & Fittings

A. An adequate length of 304 stainless steel lifting chain with shackles & clevis' shall be provided for each pumping unit. The lifting chain shall extend from the pump lifting bale to a point four (4) feet minimum above the wet well top. The working load of the lifting chain shall be 50% greater than the unit weight of the pump.

5.12 Heavy Duty Access Covers

A. DT-93 Access Cover – At the locations shown on the plans, Two Lane Vehicular access covers shall access door shall be Model DT-93 as manufactured by U.S.F. Fabrication, Inc. with the size being shown on the plans. Door leaf shall be 3/8" diamond plate reinforced for an AASHTO HL-93 wheel load. Upon request, manufacturer shall provide structural calculations showing that the door design meets the loading requirements. The unit shall be constructed with a ½" Angle with special anchoring system welded to the frame and a skirt for a 12" top slab. The unit shall have stainless steel compression springs, hold open arm, and hinges and pins. The entire frame including the seat on which the reinforcing rests shall be supported by concrete or other material designed to support the specified load. The door shall be manufactured and assembled in the United States. Manufacturer shall guarantee the door against defects in materials and workmanship for a period of ten years.
B. Fall Through Protection - The access opening shall have a permanently installed fall through protection grate system that provides continuous safety assurance in both its closed and open positions. When closed, the grate allows visibility for inspections and performance of limited maintenance below it. When open, the grate acts as an additional barrier to the access door opening. The system shall be a Hinged Hatch Safety Grate as manufactured by U.S.F. Fabrication, Inc., Hialeah, FL 1-800-258-6873 or approved equal. The fall through protection system shall consist of a grate made of 6061-T6 aluminum and be designed to withstand a minimum pedestrian load of 300 lbs. per square foot. The grate shall operate independent of the cover's reinforcing so that the cover will continue to meet specified load and deflection requirements, even if the grate is damage or removed. The grate openings shall be 4" x 6" to allow both visual inspection and limited accessibility for maintenance purposes when the grate is closed. The grate will pivot on an aluminum hinge device with 316 SS hardware that permits it to rotate upward 90 degrees and automatically lock in place. An aluminum pull rod will be attached to the grate so the operator is positioned with the grate between him and the hatch's opening whenever he pulls on it to raise the grate. A 316 SS rod will automatically engage to secure the grate in its open position, and can be lifted upward to permit the grate to close. The hatch cover will not be able to shut until the grate is closed–thereby insuring the grate is in position when the next operator

opens the hatch cover. The grate shall have an OSHA safety orange finish to increase visual awareness of the safety hazard. Installation of the fall through protection system shall be in accordance with the instructions provided by the manufacturer. The complete grate assembly shall be warranted against defects in material and workmanship for a period of 10 years from the date of purchase.

PART 6 – CONTROL PANEL

6.00 CONTROL PANEL

A. It is the intention that this specification shall cover a complete Duplex Pump Lift Station Electrical Control System as hereinafter described and all necessary appurtenances which might normally be considered a part of the complete electrical system for this installation. It shall be factory assembled, wired and tested and covered by complete electrical drawings and instructions.

B. The control system described hereafter shall be supplied by the System Supplier to provide single source responsibility for complete functioning system.

C. Signal conditioning, setpoint, control, alternation, logic function, transducer, alarm and all other control functions shall be performed by solid-state modules which shall be standard catalog items of the system manufacturer, with proven field performance.

D. At least one module of each type used in the system shall be stocked by the system manufacturer for system expansions or renewal parts purposes. The modules shall be of a compatible, integrated control family with a full range of control/protective/alternation/telemetry capabilities and associated housings, enclosure system and appurtenances to perform a variety of functions required by this project and foreseeable expansion. It is the intention of this specification to disallow non-standard, "one of a kind", experimental, unproven combinations of equipment.

E. The control unit shall be standard products manufactured and stocked by the control supplier in order to assure one source responsibility, ready availability, proper system interconnections and reliable, long-term operation.

6.01 CONTROL PANEL SCOPE

A. The equipment provided shall be a completely integrated automatic control system consisting of the required automation, and alarm

monitoring equipment in a factory wired and tested assembly. The automatic control and alarm system components shall be standard, catalogued, stocked products of the system supplier to assure single source responsibility, immediately available spare/replacement parts, proper system interconnections and reliable long term operation.

B. All equipment and materials shall be subject to the Engineer's review and shall not be purchased or manufactured until the review is complete.

C. The supplier shall prepare detailed design information, procure, configure, start-up, and make ready for use, the complete system as indicated on the plans and specifications. These submittals and drawings include descriptions of functional operation and performance, as well as standards, but do not necessarily enumerate detailed specifications for all components and devices that are essential for system operation. However, all components and devices shall be furnished and installed as required to provide complete and operable systems for accomplishing the functions and meeting the performance set forth hereinafter.

D. The system shall be installed by the contractor, complete and ready to operate, including all necessary connections to sources of electrical power, interconnection between field equipment and accessories as specified or as recommended for best operation for the equipment furnished. The hardware that is installed in the control system shall be readily available. None of the hardware in the system shall be part of a discontinued line or classified as hardware that is on repair status only. The contractor shall provide documentation verifying the continuing availability of the system hardware for full integration of the original hardware with future hardware improvements. All necessary mounting panels, stands, hangers, and brackets shall be furnished and installed and shall comply with the relevant sections of the Specifications.

E. The Supplier shall include in the bid allowance for factory-trained service personnel to adjust all the equipment until the system has been completely accepted.

6.02 QUALITY ASSURANCE

A. The Supplier shall maintain quality in both design and workmanship as well as materials used in manufacture of equipment supplied. All equipment supplied under this Contract shall be of new manufacture.

B. The Supplier shall be a firm that is engaged in the manufacturing of

process control systems. The system shall be in regular production with pre-designed hardware and software for process control systems. When the specification conflicts with a manufacturer's standard system, the standard system may be furnished if the intention of the specification is met.

C. System shall be a standard system. Custom one of a kind application software and customized hardware components will not be accepted. A standard system is defined as one which is available, at time of bid, with fully tested hardware and software, full documentation, and prepared training classes such that no development must be done beyond system configuration.

D. Supplier shall be responsible for detailed engineering, manufacture, programming, test, start-up and demonstration of all equipment and software programs to the Owner to provide a complete operating system.

E. The manufacturer shall have been continuously involved in the design and manufacture of control systems for the past ten(10) years. The manufacturer shall have successfully built and placed into operation, systems similar to the one proposed herein and will furnish a list of at least ten (10) operating installations upon request by the Engineer.

F. Provide all engineering and render coordination assistance, necessary for calibration of overall control system and to resolve interface discrepancies between panels, equipment, instrumentation and final control devices. Where interface conflicts exist, the Supplier shall document conflicts in writing to the City providing absolute information such as terminal numbers, device name, tests performed and diagnosis of problem.

G. All equipment supplied shall be of the most current and proven design at the time of delivery. The completed System and the equipment provided by the Supplier shall be compatible with the functions required and shall be a complete working System.

H. All electrical components of the System shall operate on 120 volt, single- phase, 60 Hertz current, except as otherwise noted in the specifications and on the drawings.

6.03 DOCUMENTATION

A. The complete assembly shall be provided with job-specific wiring diagrams, parts lists, enclosure dimensional and door layout drawings and instructions.

B. Production Schematics shall be submitted for approval for all equipment herein specified. The Production Schematics Submittal shall include a Document List. An Order Specification shall be included which shall describe in detail the major functionality of the equipment being provided as well as components used detailed down to major component level. Each panel shall be provided with a job-specific wiring diagram, parts list, enclosure door layout and enclosure dimension drawing. Manufacturer's wiring diagrams that are not job-specific (standard drawings with options crossed out, etc.) are not acceptable. The wiring diagram requirement applies to all field mounted instrumentation and control equipment. Interconnection details shall be shown for all field-mounted instrumentation. A Description of Operation shall be provided detailing the operation of the complete system, including the control and alarm handling.

C. Provide As-Built Drawings and Instruction Manuals. These manuals shall include corrected Shop Drawings. In addition, a detailed Programming and Operations Manual for the Microprocessor-based Controller Unit shall be included. The manual shall include all information as detailed for the Shop Drawing Submittals above.

6.04 GENERAL EQUIPMENT REQUIREMENTS

A. U.L. SERIALIZED LABEL

1. The control panel(s) shall be constructed in compliance with Underwriter's Laboratories Categories 698A and 913 standards – "Enclosed Industrial Control Panel Relating to Hazardous Locations with Intrinsically Safe Circuit Extensions" listing and following-up service. The control panel(s) shall bear the Underwriter's Laboratories serialized label for "Enclosed Industrial Control Panel Relating to Hazardous Locations with Intrinsically Safe Circuit Extensions".
2. Prior to shipment from the manufacturer's facility to the jobsite for installation, an Underwriter's Laboratories (U.L.) representative shall inspect the completed control panel(s). Upon successful completion of the inspection, the panel shall be assigned the required "Enclosed Industrial Control Panel Relating to Hazardous Locations with Intrinsically Safe Circuit Extensions" serialized U.L. label, indicating the equipment is built in accordance with the practices and requirements of the Underwriter's Laboratories 698A and 913 categories.
3. While the use of U.L. listed components is encouraged, their use alone and/or the alternate use of a U.L. 508A – "Enclosed Industrial Control

Panel" serialized label will not be considered an acceptable or satisfactory alternate to the "Enclosed Industrial Control Panel Relating to Hazardous Locations with Intrinsically Safe Circuit Extensions" serialized label specified above. Upon request from the Engineer, the panel manufacturer shall supply documentation to the owner proving they are a U.L. recognized manufacturing facility for the type of equipment required. Only the labeled products of U.L.698A and 913 "Enclosed Industrial Control Panel Relating to Hazardous Locations with Intrinsically Safe Circuit Extensions" recognized panel manufacturer shall be considered acceptable for use on this project.

B. WIRING

1. All wiring shall be minimum 600 volt UL type MTW or AWM and have a current-carrying capacity of not less than 125% of the full load current. The conductors shall be in complete conformity with the national electric codes, state, local and NEMA electrical standards. For ease of servicing and maintenance, all wiring shall be color-coded. The wire color code shall be clearly shown on the drawings, with each wire's color indicated. In addition, the equipment wiring shall be permanently marked with wire numbers that correspond to the system schematics. The numbering convention shall comply with the municipal industry standard.
2. All control wiring shall be contained within plastic/PVC wiring duct with covers. Where dimensional constraints prevent the use of wiring duct, wires shall be trained to panel components in groupings. The wire groupings shall be bundled and tied not less than every 3 inches with nylon self-locking cable ties as manufactured by Panduit or equal.
3. Every other cable tie shall be fastened to the enclosure door or inner device panel with a cable tie mounting plate with pressure tape. Where wiring crosses hinged areas such as when trained from the inner device panel to the enclosure door, spiral wrap shall be used.

C. INCOMING SERVICE AND LIGHTNING ARRESTOR

1. The service pole, metering, and main disconnect will be installed ahead of the lift station control panel as provided by the electrical contractor. Conduit and wiring between the power company termination and the lift station shall be furnished and installed by the contractor. The power supply will be 240 volts, 1 phase, 3 wire, 60 Hertz. A new disconnect shall be provided by the Electrical Contractor and is supplied by Others.
2. A lightning arrestor shall be supplied in the control system and connected to each line of the load side of main power disconnect. The arrestor shall protect the control system against damage as the result of transient voltage surges caused by lightning interference, switching loads and power line interference's. It shall begin shunting to ground at 1000 volts

maximum.

3. Each panel shall be supplied with a properly sized control power circuit breaker and fused control power transformer where necessary. The breaker shall supply power to all control wiring within the enclosure.

D. NAMEPLATES

1. All major components and sub-assemblies shall be identified as to function with laminated, engraved bakelite nameplates, or similar approved means.

6.05 CONTROL SYSTEM AND CONTROL PANEL

A. ENCLOSURE

1. The described equipment shall be housed in a NEMA Type 3R, painted white steel, at least 36" high, 30" wide, 12" deep enclosure. The enclosure door shall be provided with a three point padlock-able hasp and aluminum dead front operator's inner door.
2. This weatherproof, rain-tight enclosure shall be designed specifically for mounting in an unprotected outdoor location. It shall have a gasketed, hinged, front weather door with locking capability, and an internally mounted hinged dead front panel so that all the components normally actuated by Operating Personnel are accessible without opening the dead front and yet are not exposed to the elements or to unauthorized personnel.

B. INCOMING POWER CONNECTIONS

1. The control panel shall include a power distribution terminal block for connection of the incoming service.

C. PHASE FAILURE/UNDERVOLTAGE PUMP PROTECTION

1. Independent voltage monitors shall be provided on the load side of the pump disconnects to monitor incoming voltage and provide protection to the motors. These monitors shall detect incoming service abnormalities including unbalance, reversal, over voltage, under-voltage and rapid cycling protection and provide automatic cutout of pumps and provide local alarm. Upon detection that incoming power has returned to normal, the unit will restore pump operation and discontinue alarm. This device shall have a nominal 2-4 second dropout delay and (2-300 second) adjustable restoration time delay.

D. BRANCH CIRCUIT BREAKERS, PHASE CONVERTERS

1. A 3-phase thermal magnetic circuit breaker shall be supplied as branch circuit protection for each pump motor. The circuit breaker must have a minimum ampere interrupting capacity of (25,000 @ 240 volt) 42,000 @ 480 volt) symmetrical RMS amps. The circuit breaker shall be operable through the operator's door of the enclosure and shall have a trip rating to allow full voltage starting and continuous operation of the motors. The circuit breaker shall be a Square-D FHL Line.
2. A NEMA rated, solid state phase converter shall be connected to each pump circuit protection breaker that will internally convert the incoming single phase 240 VAC power supply to three phase 240 VAC output. The device will be sized specifically sized for the load imposed by the motors utilized herein. The units shall provide automatic voltage, current, and phase monitoring and shall be fully programmable from the operator interface provided with the unit.
3. A control power circuit breaker shall be provided and operable through the operators door of the control panel to provide a disconnect means and short circuit protection for any 120 VAC (or less) devices not powered from motor starter circuits.

E. PUMP CONTROL SELECTOR SWITCHES AND "RUN" LIGHTS

1. The control panel shall have three position selector switches mounted on the front door for Hand-Off-Auto operation of each pump. In the Hand position the motor shall be called to operate. In the Off mode the motor shall not be allowed to operate. In the Auto mode, the motor shall operate in response to control signals from the controller.
2. An operator's door mounted, 30.5mm diameter, NEMA Type 4X selector switch(s) shall be industrial rated heavy duty NEMA Type 4X with modular contact block assemblies. Contact Blocks shall be stacking screw together type with parallel double break contacts with wiping action. Contact blocks shall be rated NEMA A600, 600 Volt, 10A continuous duty, 7200VA make, 720VA break AC. Contacts shall have compression type screw terminals with self lifting spring washers to insure that the wire remains secure even under severe vibration. Snap together contact blocks are not acceptable. All pilot devices specified herein are to be Square D Series 9001, Siemens Class 52, Allen-Bradley 800-H Line.
3. Unless specified otherwise, Selector Switch(s) shall be of the maintained position type.
4. Provide a single "Lamp Test" pushbutton with dual-input lights for all specified alarm conditions. Lamp test shall also test the external, top

mounted, common alarm light. Door-mounted indicator lights shall be the LED type, NEMA 4x rated.

F. DIGITAL LIQUID LEVEL RESPONSIVE LEVEL ALARM/PUMP CONTROLLER

1. A new microprocessor based pump controller shall be furnished for monitoring and automatically controlling two submersible pumps in a pump down mode of operation in response to wet well level. Unit shall be capable of open protocol (MODBUS) communications.
2. The unit shall be a standard, catalogued product of a water and wastewater pumping automation equipment manufacturer regularly engaged in the design and manufacture of such equipment. The unit shall be specifically designed for water and wastewater pumping automation utilizing built-in preconfigured control and telemetry strategies allowing pump up or down mode pump control of 1 to 3 pumps. "One of a kind" systems using custom software with a generic programmable controller will not be acceptable.
3. The operating program shall be resident in non-volatile FLASH memory and include full-scale ranging and pump-up/down determination. The controller shall be arranged to operate up to three (3) pumps plus high and low (analog) alarms. The ON and OFF adjustments of each pump and alarm set-point shall be full-range adjustable through use of an authorized operator access code and a keypad. The controller display shall show the operation of each control stage.
4. The controller shall include keypad adjustable on-delay timing logic to provide staggered pump starting following a power failure condition. Keypad adjustable off delay timing for each pump control stage shall provide smooth transition between control stages.
5. The unit shall be able to operate on either 120 AC or 10–30 VDC power sources. The unit shall be battery backed to provide continued system monitoring and alarm annunciation in the event of primary power failure. Unit shall have built in battery charging circuitry to maintain and charge battery. Battery shall be sized to provide a minimum of 4 hours of back up power. Back up battery power will extend to necessary process sensors, local alarm lights, horns and telemetry equipment. A power on LED shall be built on board providing local indication that power is available to the unit.
6. The unit shall be furnished with a user friendly operator interface allowing adjustment and viewing of all system parameters and status with a cursory visual inspection. The operator interface shall be NEMA 4X rated suitable for front door mounting including locations requiring mounting in outdoor or corrosive environments without damage:
7. The unit shall provide on board 24 VDC loop power output for external loop

powered sensor. A built-in Analog Supply Voltage Status LED shall indicate availability of loop power. Unit shall be able to monitor a user selectable – 4-20 mA or 0-10 Volt analog input representing the process to be controlled. The analog digital conversion shall not be less than 16 digit to allow display of process to (XX.X) . The analog input circuitry shall provide optical isolation from the main board to the field device. A minimum of 1000 volts electrical isolation shall be required. The Analog process signal shall be displayed locally via 40 segment vertical LED display and the LCD digital display as specified above. This signal shall also be available for telemetry transmission.

8. The unit shall have the ability to monitor up to 16 digital inputs to be used to provide monitoring of local station status. Each discrete input shall provide optical isolation from the main board to the field device. A minimum of 1500 volts electrical isolation shall be required. An on board LED shall be provided indicating that digital Input isolation is not compromised. All discrete inputs shall be available for telemetry transmission. The following inputs shall be monitored:
    - Pump 1, 2 Run – This signal shall be used to provide local display of pump run status, pump total run time, pump average daily starts. For each pump.
    - Pump 1, 2 In Auto – This signal shall be used by the controller to determine pump availability. A pump *not* in this mode, cannot be called into operation.
    - Pump 1, 2 High Temperature/Seal Failure – These signals shall be used by the controller to disable the affected pump when a High Temperature Signal is received from the pump, and provide local alarm display. Controller shall be able to differentiate High Temperature and Seal Failure alarms. . A Seal Failure shall be reported as an alarm, and shall also disable the affected pump operation. A High Temperature alarm or a Seal Failure alarm from one pump shall not affect the normal operation of the remaining pump.
    - High & Low Float/Pressure – This signal shall be used by the controller to provide back up control of the pumps in the event of primary (analog) sensor failure.
    - Pump Inhibit – This signal shall be used by the controller to inhibit pumps from operating
    - Power Quality – This signal shall be used by the controller to disable pumps in the event incoming station power is unsuitable for use as determined by the external alarm disabling switch.
    - Door Switch & Door Acknowledge– These signals shall be used by the controller to monitor station access as detected by an external door/limit switch and an external alarm disabling switch.

- Alarm Silence – This signal shall be used by the controller to monitor an external silence push button and will temporarily disable the alarm horn output.

9. The LCD display screen shall operate in a manual scrolling menu mode with the various displays shown in sequence as selected by the keypad's up/down arrow keys. The display shall indicate the specific function entered on the keypad to confirm that selection of a particular output or other function from the keypad during adjustment or review routines.
10. The unit shall be protected from unauthorized changes via built-in system security. The unit shall support 3 levels of security in a hierarchical structure allowing different levels of access to the unit for differentiation of desired assess levels to include Operator, Maintenance, & Supervisory access levels.
11. The unit shall provide outputs for interface to local pumps and alarm annunciation equipment. Relay isolated contact outputs for activation of Pump 1 and Pump 2 Common Alarm and Alarm Horn shall be provided. Each contact shall be rated for a minimum of 10 amps at 120 VAC or 5 Amps at 240 VAC. Open collector outputs for Low and High Level Alarm shall be provided for interface to off board monitoring equipment. Open collector outputs shall have a minimum operating range of 5-30 VDC @ 100 mA.
12. The unit shall be capable of providing 4-20 mA output signal for interface to external equipment including VFDs, Chart Recorders or other monitoring devices. Analog output can be configured to provide output representing process variable for retransmission or as a process control output for interface to VFDs, valves, or other process controlled device.
13. The unit shall support contact closure inputs from float or pressure switches representing high and low (*Level/Pressure*). The unit shall annunciate these inputs as alarms and use them to provide back up control in the event the primary (analog) sensor fails. Unit will provide local alarm indication and utilize the inputs to cycle pumps on and off to maintain system operation.
14. The unit shall have built-in standard operator adjustable alternation functions allowing for sequencing and equalizing wear of the pumps. The following alternation sequences shall be supported:
    - Fixed
    - Rotary
    - First On First Off (FOFO)
    - Utilize One Favor Others (UOFO)
    - Emergency Mode
15. The unit shall include built-in Pump Failure detection logic. In the event the pump has been called into operation and the pump run signal is not received within a pre-adjustable time period. A motor failure shall be

produced. The failed motor shall be disabled, an alarm shall be displayed and the next available pump based on the selected alternation sequence shall be requested to start.

16. The controller shall include built in site intrusion detection logic that will monitor an external sensor (motion sensor, door switch, etc…) and allow authorized access to the station via controller keypad entry of proper security code or access level. The intrusion system upon detection of entry, will allow a preset amount of time for the operator to go the controller keypad and enter the proper code. When the operator logs out and leaves the facility, the controller shall allow a preset amount of time for the operator to get out before re-arming.
17. In addition to the pump and alarm control capability, the controller shall provide alarm annunciation. The controller shall, upon the occurrence of an alarm, sound an audible device and flash the alpha-numeric display. The display will indicate the alarm description, complete with the time and date of the alarm occurrence. An acknowledge pushbutton shall be provided to allow silencing of the audible device while the digital display will continue to show the alarm function, complete with time and date information, until the condition has cleared. A built-in alarm and status historian shall retain the last 100 time and date stamped events providing a historical record of recent activity.
18. The unit shall have one (1) RS-232C serial communications port that shall be available for telemetry communications. The RS-232 serial port shall support completely open communication standards. Unit shall support communication data rates of 1,200 to 38,800 baud rates. On board communication diagnostic LEDs shall be available to provide indication of communications activity for verification and troubleshooting.
19. Unit shall be constructed for industrial applications for use in harsh environments. Unit shall have a Temperature Operating range of -40 to + 85 Deg C, and be able to operate in environments with 10-90% non condensing humidity. Unit shall be UL Listed and in compliance with FCC part 15 Class A emissions and CE IEC61000 Surge Withstand certifications.
20. All connections shall be made via plug-in terminal blocks with a minimal rating of 10 Amps, 300 Volts and capable of accepting 30-12 AWG wire.
21. It is the intention of this specification that a standard controller/transceiver be provided, with all of the control and communications features described as a fully-integrated assembly.
22. The pump controller shall contain all relays and electronic equipment required to interface with each pump motor thermal protection and seal failure switches. The pump controller shall also be furnished with all relays and electronic devices required to interface with the solid state motor overload relays, and motor contactor auxiliary switches.

G. SUBMERSIBLE LEVEL TRANSDUCER

1. The liquid level of the wet well shall be sensed by a submersible level transducer. The transducer shall be a 2-wire type to operate from the level controller's regulated loop power supply and produce an instrumentation signal (4-20mA) in direct proportion to the measured level excursion over a factory-calibrated range of zero to (30) feet of water.

2. The transducer shall be of the ceramic capacitive, relative pressure sensing type, suitable for continuous submergence and operation and shall be installed in accordance with manufacturer's instructions. The bottom diaphragm face of the sensor shall be installed approximately 6 inches above the wet well floor. The sensor shall be hung in the wet well using a cable bracket including two sliding cable locking jaws in a location in the wet well and as shown on the job plans.

3. The transducer housing shall be fabricated of PPS (polyphenylene sulfide) with a ceramic bottom diaphragm.

4. The transducer element shall incorporate high over-pressure protection and be designed to withstand intermittent overpressures (10) times the full-scale range being sensed. Metallic diaphragms shall not be acceptable in that they are subject to damage or distortion. Sensing principles employing LVDTs, resistive or pneumatic elements shall not be acceptable.

5. The internal pressure of the lower transducer assembly shall be relieved to atmospheric pressure through a heavy-duty urethane jacketed hose/cable assembly and a slack PVC bellows mounted in the control panel. The sealed breather system shall compensate for variations in barometric pressure and expansion and contraction of air due to temperature changes and altitude as well as prevent fouling from moisture and other corrosive elements.

6. The transducer assembly shall be installed where directed by the Engineer and connected with other system elements and placed in successful operation

7. The transducer shall have a programming feature using a standard USB interface and a laptop computer, the servicing transmitter can be programmed on-the-fly to the required measuring range.

8. The design without sharp edges prevents particles, textiles and paper from sticking to the housing or the diaphragm. The transducer shall be surge resistant.
9. The transducer power cable shall be steel reinforced PUR cable with high tensile strength (2,000 lb).

H. CONVENIENCE RECEPTACLE

1. An operator's door mounted 120 VAC duplex ground fault interrupter (GFI) type, convenience receptacle rated at 15 amperes shall be supplied for the operation of a trouble light, drill, etc. It shall be protected by a separate 15 ampere trip rated circuit breaker accessible from the operator's door.

I. LOCAL ALARM LIGHT

1. A top mounted weatherproof, strobe alarm indication light assembly with shatter resistant polycarbonate red lens mounted on a polycarbonate/ABS blend case shall be provided. The alarm light shall be NEMA 4X rated, suitable for indoor or outdoor mounting and operate on 120 VAC and be PLC rated. The strobe tube shall provide a minimum of 300,000 peak candela output and shall be rated for 3,000 hour life. The alarm light shall flash upon occurrence of an alarm condition.

J. CONDENSATION PROTECTIVE HEATER

1. A 100 watt, 120 VAC condensation protective heater and adjustable high temperature cutout thermoswitch shall be supplied in the control panel. The heater's surface area for heat dissipation shall be large enough to prevent a skin burn (if an operator's hand should inadvertently come in contact with the unit when energized). The heater shall be regulated by a humidistat located within the control panel enclosure.

K. CONTROL PANEL SERVICE, TRAINING AND GUARANTEE

1. The services of a factory trained, qualified representative shall be provided to inspect the completed installation, make all adjustments necessary to place the system in trouble-free operation and instruct the operating personnel in the proper care and operation of the equipment.
2. After each system has been installed, the Supplier shall demonstrate with performance of each unit, and document that the system operates properly as specified.
3. The Supplier shall provide systems training for operations staff totaling no less than 2 hours.
4. All training shall be conducted at the site. Travel expenses are the responsibility of the supplier.
5. All equipment shall be guaranteed against defects in material and workmanship for a period of one year from the date of Owner's final

inspection and acceptance to the effect that any defective equipment shall be repaired or replaced without cost or obligation to the Owner.

PART 7 - EXECUTION

7.01 INSPECTION

A. Inspect all equipment upon arrival at job site and prior to installation. Notify manufacturer of any damage and/or shortage.

B. Inspect concrete mounting pads and anchor bolts for correct size and alignment prior to installation.

7.02 PREPARATION

A. Make corrections and/or repairs as required for items inspected and found to be deficient.

7.03 INSTALLATION

A. Install pumps and accessories in strict accordance with the manufacturer's instructions.

7.04 FIELD QUALITY CONTROL

A. The manufacturer's field engineer or representative shall inspect and check the installation after erection and be on hand for initial start-up of the equipment for a period of at least three (3) days. He shall also instruct operating personnel in the operation and maintenance of the system.

7.05 ADJUSTING AND CLEANING

A. Adjust equipment as required and within limits of manufacturer's instructions for proper alignment.

B. Apply proper type and quantity of lubricants for short term storage or start-up operation as applicable.

C. Clean equipment of any foreign matter or substances.

D. Field paint all components to be painted in accordance with manufacturers recommendations.

7.06 PROTECTION

A. After installation and painting protect the equipment from any damage by work of other trades. Repair any damage that nevertheless may occur.

PART 8 - SERVICE AND WARRANTY

8.01 SERVICE

A. The pump manufacturer shall have an authorized factory service center capable of completely servicing the proposed pumps within 100 miles of the project site. The pump manufacturer shall have a ***factory direct*** service center/stocking facility capable of completely servicing, and which stocks identical complete drive units, and spare parts for, the proposed pumps within 100 miles of the project site.

8.02 PUMP WARRANTY

A. The pump manufacturer shall provide prorated warranty for the units supplied to the Owner against defects in material and workmanship for a period of at least five (5) years or 10,000 operating hours in writing under the operating conditions presented by this project. Pump manufacturer shall demonstrate ability to support claimed warranty coverage by meeting all requirements of Section 4.01 of this specification.

B. The manufacturer guarantees the installation to be free from clogging when pumping sewage and wastewater containing solids and debris normally found in domestic wastewater. This guarantee is extended to the original owner for a period of 12 - months from the date of start - up of the equipment by the Local Authorized Distributor. Should the pump impeller clog with typical solids and/or debris normally found in domestic wastewater during this period, the manufacturer shall reimburse the owner for reasonable cost to remove the pump, clear the obstruction and reinstall the affected pump unit. The manufacturer reserves the right to inspect the pump station, pump units and possibly modify the pump unit, if deemed necessary, to mitigate any further occurrence of pump clogging at no cost to the owner.

END OF SECTION

4884 HIGHWAY 61

CITY OF MEMPHIS

SARP10 PROGRAM

DECEMBER 1, 2021
CONSTRUCTION DOCUMENTS

PREPARED BY: PICKERING FIRM, INC.

FOR REFERENCE – SEE PLANS FOR PROJECT REQUIREMENTS

SECTION 11310 – WET WELL MOUNTED PUMP STATION WITH DUPLEX NON-CLOG PUMPS

GENERAL

The contractor shall furnish and install one factory-built, automatic pumping station as manufactured by Smith & Loveless, Inc., or approved equal. The station shall be complete with all needed equipment, factory-installed on a welded steel base with a hinged fiberglass cover.

The principal items of equipment shall include two vertical, close-coupled, motor driven, vacuum primed, non-clog pumps; valves; internal piping; central control panel with circuit breakers; motor starters and automatic pumping level controls; heater; ventilating blower; priming pumps with **SONIC START®** pump prime detection system and appurtenances; and all internal wiring.

OPERATING CONDITIONS

Each pump shall be capable of delivering * GPM (l/s) of raw water or wastewater against a total dynamic head of * feet (m). The minimum acceptable pump efficiency at this condition shall be 51%. Due to the energy conservation requirements, the minimum efficiency will be enforced. The maximum allowable speed shall be * RPM. The minimum rated horsepower (kw) of each pump motor shall be * . The actual static suction lift, measured from the station baseplate to the "off" level in the wet well, shall be 21.0' (m) at *' (m) elevation above Mean Sea Level. The pumps shall be capable of meeting or exceeding this value, at the specified altitude.

The minimum specified pump efficiency is _%. Should a Contractor wish to propose an alternate pump which does not meet or exceed the specified efficiency, the Contractor will be required to provide, 15 days prior to the bid opening, a pre-bid submittal packet with the proposed pump details, pump curve and efficiency. The submittal will be accompanied by a 25 year cost of operation difference calculation. The energy cost difference, due to reduced efficiency, over a 25 year period, calculated at $** per KWH, shall be applied as an adder when evaluating the alternate manufacturer's bid number.

All openings and passages shall be large enough to permit the passage of a sphere 3" (75 mm) in diameter and the pump shall have a flanged suction and discharge connection no smaller than 4" (100 mm). The anticipated operating head range is from * feet (m) minimum to * feet (m) maximum. The pump motors shall not be overloaded beyond their nameplate rating at the design conditions nor at any head in the operating range.

*- Refer to Design Drawings for Pump Data at each site.
**- Refer to standard power rates per Memphis Light Gas and Water Division

CONSTRUCTION

The station shall be constructed in one complete, factory-built assembly. It shall be sized to rest on the top of the wet well as detailed in the construction drawings.

A. EPOXY COATED CARBON STEEL BASEPLATE

The supporting floor plate shall be minimum [3/8" (9.5 mm), ½" (13 mm), 1" (25 mm)] thick carbon steel with reinforcing, as required, to prevent deflection and ensure an absolutely rigid support. Steel plate shall meet or exceed ASTM A-36 specifications.

WELDING

All steel structural members shall be joined by electric arc welding with welds of adequate section for the joint involved. Structural welding shall be preformed in accordance with AWS standards and procedures.

PROTECTION AGAINST CORROSION

All structural steel surfaces shall be factory blasted with steel grit, in an environmentally controlled booth, to remove rust, mill scale, weld slag, etc. All weld spatter and surface roughness shall be removed by grinding. Surface preparation shall comply with SSPC-SP6 specifications. Sandblasting is specifically prohibited.

Immediately following cleaning, a single 6-8 mil (0.15-0.20 mm) dry film thickness coating of VERSAPOX®, a self-priming

Cycloaliphatic Amine Epoxy shall be factory applied to the base. After curing, a 2-3 mil (0.05-0.08 mm) DFT top coating of XTRATHANE™, a moisture-cured Aliphatic Polyurethane protective finish, for abrasion resistance and weather protection, shall be applied to the top of the base. These coatings shall be as formulated by Smith & Loveless specifically for this type of application and service.

Stainless steel, aluminum and other corrosion-resistant surfaces shall not be coated. Carbon steel surfaces not otherwise protected shall be coated with a suitable non-hardening rust preventative compound. Auxiliary components such as the electrical enclosure, ventilating blower and vacuum pumps shall be furnished with the original manufacturer's coating.

Finish coating shall be accomplished prior to shipment of the station from the factory and shall comply fully with the intent of these specifications. A touch-up kit shall be provided by the pump station manufacturer for repair of any mars or scratches occurring during shipping and installation. This kit shall contain detailed instructions for use.

MAIN PUMPS

The pumps shall be 4" vertical, centrifugal non-clog type of heavy cast-iron construction, especially designed for the use of mechanical seals and vacuum priming. In order to minimize seal wear caused by linear movement of the shaft, the shaft bearing nearest the pump impeller shall be locked in place so that endplay is limited to the clearance within the bearing. To minimize seal wear resulting from shaft deflection caused by the radial thrust of the pump, the shaft from the top of the impeller to the lower bearing supporting the impeller shall have a minimum diameter of 1-7/8" (48 mm) for motor frame sizes 213 through 286; 2-1/8" (54 mm) for motor frame sizes 324 and 326; and 3" (76 mm) for frame 364 and larger. The dimension from the lowest bearing to the top of the impeller shall not exceed 6" (152 mm). The motor shaft shall be directly connected to the impeller without the use of drive belts or couplings, which require alignment and maintenance, and which increase power consumption due to their inherent energy losses.

Pumps with less than a standard 4" (100 mm) suction or 4" (100 mm) discharge connection, or with less than a 3" (76 mm) spherical solids handling capacity will be rejected for this application.

The oversized shaft incorporating oversized bearings and heavier bearing frame construction provides for extended mechanical seal, bearing and overall pump/motor life. Since the larger shaft with the specified minimum overhang is the key to heavier, more rigid construction throughout, no deviation from the specified shaft diameter or tolerances will be allowed.

The bearing nearest the impeller shall be designed for the combined thrust and radial load. The upper bearing shall be free to move in a linear direction with the thermal expansion of the shaft and shall carry only radial loads.

The shaft shall be solid stainless steel through the mechanical seal to eliminate corrosion and abrasive rust particles. Removable shaft sleeves will not be acceptable if the shaft under the sleeve does not meet the specified minimum diameter.

The pump shall have an integral adapter providing a large water reservoir above the impeller to provide for positive exclusion of air from the impeller. The seal shall be inside this area to assure lubrication. Pumps which do not use hollow priming adapters for positive lubrication of the seal will not be acceptable. Self-priming pumps are specifically unacceptable due to the need for suction check valves, air vent piping and the possibility of overheating and damaging the pump or producing steam or high temperatures in the pump, which may be a hazard to the operator, when the pump is run dry.

The pump controls must be set so that the main pumps cannot be turned on unless they are filled with liquid, and the pump is completely primed.

The pump shall be constructed so as to permit priming from the lower pressure area behind the impeller. Priming from high-pressure connections, which tends to cause solids to enter and clog the priming system, will not be acceptable. The priming bowl shall be transparent, enabling the operator to monitor the priming level.

The pump shall be arranged so that the rotating element can easily be removed from the casing without disconnecting the electrical wiring or disassembling the motor, impeller, backhead or seal, so that any foreign object may be removed from the pump or suction line. Enclosed impellers must be used to avoid the necessity of wear plates and the associated costs of replacement and maintenance of wear plate clearances with semi-open impellers.

The pump shaft shall be sealed against leakage by a single mechanical seal constructed so as to be automatically drained and primed each time the pump is drained and primed. Water, which lubricates the mechanical seal, shall be automatically drained

from around the seal if the pump loses prime in order to allow both the pump and the seal to be drained, thereby preventing freezing and breakage of the seal during power outages in sub-freezing temperatures.

The seal shall be of carbon and ceramic materials with the mating surfaces lapped to a flatness tolerance of one light band. The rotating ceramic shall be held in mating position with the stationary carbon by a stainless steel spring. The entire seal assembly shall be held in place by a bronze seal housing to prevent excessive heat buildup. Use of cast-iron or other ferrous material for the seal housing which will rust and damage the seal, shortening its life, will not be acceptable.

The pump volute shall be furnished with mounting lugs and bolted to the station floor plate, forming a gas-tight seal.

A. NON-CLOG TWO-PORT IMPELLER (4" & 6" PUMP OPTION) [(100 & 150 MM PUMP OPTION)]

The pump impeller shall be of the enclosed two-port type made of close-grained cast-iron and shall be balanced. The eye of the impeller as well as the ports shall be large enough to permit the passage of a sphere 3" (76 mm) in diameter in accordance with nationally recognized codes. The impeller shall be keyed with a stainless steel key and secured to the motor shaft by a stainless steel capscrew equipped with a Nylock or other suitable self-locking device. The impeller shall not be screwed or pinned to the motor pump shaft and shall be readily removable without the use of special tools. To prevent the buildup of stringy materials, grit and other foreign particles around the pump shaft, all impellers less than full diameter shall be trimmed inside the impeller shrouds. The shrouds shall remain full diameter so that close minimum clearance from shrouds to volute is maintained. Both the end of the shaft and the bore of the impeller shall be tapered to permit easy removal of the impeller from the shaft.

MOTORS

The pump motors shall be vertical, solid shaft, NEMA P-base, squirrel-cage induction type, suitable for 3 phase, 60 cycle, 230 volt electric current.

They shall have Class F insulation. Insulation temperature shall, however, be limited to Class B. The motors shall have normal starting torque and low-starting current, as specified by NEMA Design B characteristics. They shall be open drip-proof design with forced air circulation by integral fan. Openings for ventilation shall be uniformly spaced around the motor frame. Leads shall be terminated in a cast connection box and shall be clearly identified.

The motors shall have 1.15 service factor. The service factor shall be reserved for the owner's protection. The motors shall not be overloaded beyond their nameplate rating, at the design conditions, nor at any head in the operating range as specified under Operating Conditions.

The motor-pump shaft shall be centered, in relation to the motor base, within .005" (0.127 mm). The shaft runout shall not exceed .003" (0.076 mm).

The motor shaft shall equal or exceed the diameter specified under Main Pumps at all points from immediately below the top bearing to the top of the impeller hub.

A bearing cap shall be provided to hold the bottom motor bearing in a fixed position. Bearing housings shall be provided with fittings for lubrication as well as purging old lubricant.

The motor shall be fitted with heavy lifting eyes or lugs, each capable of supporting the entire weight of the pump and motor.

The pump motors shall be Premium Efficiency type, per NEMA MG-1 table 12-12, Inverter Ready per NEMA Part 31.4.4.2, with cast-iron frames, and be UL Recognized and CSA Approved. The motor windings shall be 200 C Inverter Spike-Resistant magnet wire and the rotors shall have an epoxy coating for corrosion protection.

CONTROLS

The control equipment shall be mounted in a NEMA Type 1 steel enclosure with 2 hinged access doors.

A grounding-type convenience outlet shall be provided on the side of the cabinet for operation of 120-volt AC devices.

Thermal magnetic air circuit breakers shall be provided for branch disconnect service and short circuit protection of all motor

control and auxiliary circuits.

Magnetic across-the-line starters with under-voltage release and overload coils for each phase shall be provided for each pump motor to give positive protection. Each single-phase auxiliary motor shall be equipped with an over-current protection device in addition to the branch circuit breaker, or shall beimpedance protected.

All wiring shall be labeled with thermal transfer self-laminating labels and a coded wiring diagram shall be provided.

FLOAT SWITCH LEVEL CONTROLS

To control the operation of the pumps with variations of liquid level in the wet well, a minimum of three (3) displacement switches shall be provided. A 30' (9 m) cord shall be provided with each switch. The cord shall have a corrosion-resistant vinyl jacket and be multi-stranded in order to prevent fatigue.

The displacement switch cords shall enter the wet well through cord grip seals mounted to a removable, gasketed floor plate. The floor plate shall allow the displacement switches to be adjusted or removed and replaced without having to enter or reach into the wet well.

An automatic alternator with manual switch shall be provided to change the sequence of operation of the pumps every eight hours. Alternating the pumps at less than eight-hour intervals will not be acceptable.

Provisions shall also be made for the pumps to operate in parallel should the level in the wet well continue to rise above the starting level for the low level pump.

HIGH WET WELL LEVEL ALARM

An adjustable displacement switch shall be provided to sense a high water level condition. The switch shall hang into the wet well and shall activate a contact to indicate the high water condition.

RUNNING TIME METER

A running time meter shall be supplied for each pump to show the number of hours of operation. The meter shall be enclosed in a dust and moisture-proof molded plastic case. The flush-mounted dial shall register in hours and tenths of hours up to 99,999.9 hours before repeating. The meter shall be suitable for operation from a 115-volt, 60 (50)-cycle supply.

PUMP FAILURE TO PRIME OR FAILURE TO PUMP ALARM (CHECK VALVE SWITCH TYPE)

To sense failure to deliver normal flow for any reason, including failure to prime, each pump shall be provided with a sealed sensor switch mounted in a protective ABS enclosure. The enclosure shall be mounted with an adjustable universal mounting bracket to the external arm of each discharge check valve. The mounting bracket shall allow the adjustment of the sensor switch with a single locking pivot adjustment. A red LED indicating light shall be provided on each switch unit to facilitate accurate setting of the switch for proper operation. The sensor switch shall monitor the movement of the check valve arm and thereby detect failure of the pump to deliver normal operating flow when called on to run. An auxiliary time delay relay shall be provided to prevent an alarm signal during the pump priming and startup period.

VACUUM-PRIMING SYSTEM

A vacuum priming system shall be furnished to prime the main pumps. The system shall be as shown on the vacuum priming schematic and shall include two vacuum pumps, providing 100 percent standby. Vacuum pumps shall have corrosion-resistant internal components. The vacuum priming system shall be complete with large port vacuum control solenoid valves, **SONIC START®** prime level sensor, float-operated check valves to protect the vacuum pumps, and all necessary shut-off valves as shown on the piping schematic. The float-operated check valves shall have a transparent body for visual inspection. All hoses and tubing used in the priming system shall be at least 3/8" (9.5 mm) nominal diameter.

The solenoid valves used in the vacuum priming system shall be of the high flow, direct acting brass body type, with threaded ports, NBR seals and 300 Series stainless steel plunger, rod, plate and springs.

The minimum orifice diameter shall be 5/16" (8 mm). The solenoid valves shall be UL Listed, with Class F coil rating and of suitable voltage and thermal capacity for the application.
Liquid level in the pump priming chamber shall be monitored by a **SONIC START®** resonant frequency liquid level probe.

The probe shall be equipped with a piezoelectric drive and sensitive circuits to detect frequency shifts when the probe is covered by liquid. The probe shall be completely sealed and have a 316L stainless steel housing for corrosion resistance. It shall be provided with a wiring connector molded of PolyPhenylSulfone, an amorphous high performance thermoplastic for impact and chemical resistance. The probe shall have a plug-in connector to facilitate easy removal.

The **SONIC START®** probe shall be provided with light emitting diodes. This diagnostic tool shall indicate connectivity, prime status or a fault condition. Systems utilizing an electrode, mechanical means such as a float, or that require any type of electrical or moving parts inside the priming chamber, which may accumulate debris, short out, bind or fail will not be acceptable.

The priming system shall automatically provide positive lubrication of the mechanical seal each time a main pump is primed. To prevent excessive stoppage due to grease accumulation, no passageway in the priming system through which the pumped liquid must pass shall be smaller than the equivalent of a 2-1/2" (64 mm) opening.

The vacuum priming system shall have two field selectable modes of operation. In the "On-Demand" mode, the priming system will operate only after a pump is called on to run, and if it is not primed. Once primed, the pump will be allowed to run. In the "Constant Prime" mode, both pumps are kept primed continuously, and ready to start immediately when called for.

ENVIRONMENTAL EQUIPMENT

A ventilating blower capable of delivering 250 CFM at 0.1" (118 l/s at 2.5 mm) static water pressure shall be provided in order to remove the heat generated by continuous motor operation. The ventilating blower shall be turned on and off automatically by a preset thermostat. A heavy extruded aluminum louvered grille with adjustable openings shall cover the discharge of the blower. A similar grille shall be provided in the other end of the station enclosure for air intake. A 500-watt electric heater controlled by a preset thermostat shall be furnished. The heater shall be rigidly mounted in the station to prevent removal.

SINGLE-PHASE 120-VOLT POWER TRANSFORMER PACKAGE

Suction Pipe Size	Aux. Heater	Min. Transformer Size
4"	No	3 KVA 208v
4"	No	2 KVA 230/460v
4"	Yes	3 KVA 208/230/460v
6" or 8"	No	*5 KVA 208/230/460v
6" or 8"	Yes	*5 KVA 208/230/460v

***[5 KVA NOT AVAILABLE WITH 4*2* PUMPS WITH 4" PIPING. USE 3 KVA]**

A (2) (3) (5) KVA insulating-type transformer shall be provided to supply power for lights, controls and auxiliary devices. The transformer shall have 240/480 volt primary, 120/240 volt secondary, Class F insulation, with temperature rise not to exceed 115°C above 40°C ambient. The core and coil assembly shall be given a double dip and bake. The coil shall be protected by a metal housing to prevent damage. The transformer shall be protected by a separate circuit breaker on the supply side.

.

MAIN PIPING

The pump suction connections shall be drilled and tapped for a 125-pound American Standard flange for easy attachment of the suction risers. The discharge line from each pump shall be fitted with a clapper-type check valve and eccentric plug valve. Size, location and quantity of check valves and plug valves shall be as shown on the construction drawing.

The check valve shall be of the spring-loaded type with external lever arm and an easily replaced resilient seat for added assurance against vacuum leaks. Check valves shall have stainless steel shaft with replaceable bronze shaft bushings. Ball-type check valves are specifically unacceptable for this application. An operating wrench shall be provided for the plug valves. All station piping and fittings shall be capable of passing a 3" (76 mm) spherical solid.

RAPID-JACK™ CHECK VALVE

The cast iron check valve body shall be designed so that the upper portion may be easily removed, without disturbing the end flange seals to adjacent piping, to service the shaft, arm and clapper or to remove any material which may be causing clogging. Provide one spare body gasket for each valve.

Protrusions through the station floor shall be sealed where necessary to effect sealing between the equipment chamber and the wet well. The suction and discharge connections, where they pass through the floor, shall be sealed by gaskets in order to prevent corrosive, noxious fumes from entering the station. Welded joints that do not allow adjustment or replacement will not be considered for this application. The pump station manufacturer shall extend the suction and discharge connections below the floor at the factory so that field connections can be made without disturbing the gas-tight seals.
Once the station is installed, however, it shall be possible to remove the entire 4" or 6" (100 or 150 mm) suction pipes through the station floor without having to enter the wet well to unbolt them.

The manufacturer of the pump station shall provide a compression-type sleeve coupling for installation on the common discharge pipe. A minimum of two anchoring points shall be provided on the bottom of the station baseplate for attachment of coupling joint restraints, which shall be provided by the installing contractor.

PROTECTED LIQUID FILLED COMPOUND PRESSURE GAUGES

A four-inch (4") (100 mm)Bourdon tube-type compound vacuum/pressure gauge with 3-1/2" (89 mm) dial, fitted with a brass stop valve and a manual air relief valve shall be provided for each pump. The gauges shall be mounted apart from the pumps, on a bracket attached to the control panel support structure, and connected to the pump discharge taps by flexible tubing to minimize vibration. The range of each gauge shall be selected to place the normal operating discharge pressure reading in the middle one-third of the scale and the gauge shall also be capable of measuring up to 30" HG (1.0 bar) of vacuum. The dial shall be white with black markings and the gauge itself shall have an accuracy of 1% of scale. The gauge shall be American made, with a Zytel Nylon case with 1/2" (13 mm) blow-out plug, stainless steel bezel, acrylic lens and phosphorus bronze tube with brass socket. Temperature compensation shall be provided by an internal compensating diaphragm. Gauges shall be protected from the service fluid by a Buna-N elastomer "boot" diaphragm within the stem, and the Bourdon tube and the space between the Bourdon tube and the internal isolating diaphragm shall be filled with low temperature instrument oil, completely isolating the gauge components from the fluid being measured.

CHECKLIST

The pump and pump station specifications and the following checklist must be met in total. There are many reasons for incorporating a good pump specification. For example, the stainless steel shaft with tapered impeller attachment is provided to minimize corrosion, extend seal life, and provide ease of impeller removal and seal replacement without use of a wheel puller. All items specified are for long life, durability and maintainability of the pumping equipment. Deviations from the pump specification will not be allowed.

The checklist is also provided to insure that the proper pumping system is provided to the owner.

FACTORY TESTS

All components of the pump station shall be given an operational test at the pump station manufacturer's facility to check for excessive vibration or leaks in the piping or seals, and to correct operation of the automatic control and vacuum priming systems and all auxiliary equipment. Installed pumps shall take suction from a deep wet well, simulating actual service conditions. The control panel shall undergo both a dry logic test and a full operational test with all systems operating.
Factory test instrumentation must include flow measuring with indicator; compound suction gauge; Bourdon tube-type discharge pressure gauge; electrical meters to measure amperes, volts, kilowatts and power factor; speed indicator; and a Vibrometer capable of measuring both amplitude and frequency.

SPARE PARTS

A complete replacement pump shaft seal assembly shall be furnished with each pump station. The spare seal shall be packed in a suitable container and shall include complete installation instructions. A spare volute gasket and seal gasket shall be provided.

An instructional video presentation on the pump mechanical seal system in DVD format shall be included. The DVD shall contain a presentation on the following subjects: purpose and location of the mechanical seal, signs of a defective mechanical seal, how to remove the mechanical seal, troubleshooting seal failure causes, seal components, required tools, how to reinstall the seal and how to place the pump back into service. The video shall include footage of an actual seal replacement.

INSTALLATION AND OPERATING INSTRUCTIONS

Installation of the pump chamber shall be done in accordance with the written instructions provided by the manufacturer.

Operation and maintenance manuals shall be furnished which will include parts lists of components and complete service

procedures and troubleshooting guide.

STARTUP

The Manufacturer shall provide the services of a factory-trained representative for a maximum period of one day on-site to perform initial startup of the pump station and to instruct the owners operating personnel in the operation and maintenance of the equipment.

WARRANTY

The manufacturer of the station shall warrant for one (1) year from date of start-up, not to exceed eighteen (18) months from date of shipment, that the structure and all equipment he provides will be free from defects in material and workmanship. Warranties and guarantees of the suppliers of various components in lieu of a single source responsibility by the Manufacturer will not be accepted. The Manufacturer shall assume prime responsibility for the warranty of the station and all components.

In the event a component fails to perform as specified or is proven defective in service during the warranty period, the Manufacturer shall repair or replace, at his discretion, such defective part.

He shall further provide, without cost, such labor as may be required to replace, repair or modify major components such as the steel structure, and main piping manifold. After start-up service has been performed, the labor to replace accessory items, such as the blower, priming pumps, alternator, etc., shall be the responsibility of others.

It is not intended that the Manufacturer assume responsibility for contingent liabilities or consequential damages of any nature resulting from defects in design, material, workmanship or delays in delivery, replacement or otherwise.

The motor adapter, volute, impeller, fiberglass enclosure and steel base shall be covered by a 10-year pro-rated warranty. The fiberglass enclosure shall be warranted against failure of the fiberglass components. The steel base shall be warranted against structural failure and perforation due to corrosion.

The pro-rated warranties shall be computed on a monthly basis starting at shipment, and shall cover replacement parts only.

The repair or replacement of those items normally consumed in service, such as grease, light bulbs, etc., shall be considered as part of routine maintenance and upkeep.

The manufacturer shall provide a warranty certificate covering specific details.

MANUFACTURER'S INSURANCE

ALL EQUIPMENT MANUFACTURERS, either direct or subcontractors to the general or mechanical contractors, SHALL HAVE in effect at TIME OF BID, CONTRACT AWARD, CONTRACT PERFORMANCE, and WARRANTY TERM, PRODUCT AND COMPREHENSIVE LIABILITY INSURANCE, INCLUDING SUDDEN AND ACCIDENTAL POLLUTION COVERAGE in the amount of FIVE MILLION DOLLARS, $5,000,000, through an insurance company with a minimum rating of A+ (SUPERIOR) XV according to the BEST'S INSURANCE REPORTS. All policies must be written on an OCCURRENCE BASIS. Policies written on a CLAIMS MADE BASIS are not acceptable. A typical CERTIFICATE OF INSURANCE attesting to the specified coverage issued by the responsible carrier naming the ENGINEER OF RECORD and the OWNER as ADDITIONAL INSURED must be presented to the named additional insured prior to contract award. A FAILURE TO COMPLY with this requirement BY THE BIDDER will require DISQUALIFICATION of the BID and CONTRACT AWARD.

MANUFACTURED EQUIPMENT
OPTION 1 (STANDARDIZATION)

The specifications and drawings detail Smith & Loveless equipment and represent the minimum standard of quality for both equipment and materials of construction. The contractor shall prepare his bid on the basis of the particular equipment and materials specified for the purpose of determining the low bid.

The owner has standardized on the named equipment in order to optimize their operation, facilitate maintenance and safety programs, provide for interchangeability of costly equipment items, reduce stocking levels required for necessary spare parts

and provide increased flexibility in the utilization of their pumping equipment. Equipment substitutions, since incompatible with the district's standardization program, will not be considered.

BID SUBMITTAL

This submittal shall include all necessary information for the proper determination of the acceptability of the proposed substitution and shall not necessarily be limited to the following.

A. Complete description of the equipment, system, process, or function, including a list of system components and features, drawings, catalog information and cuts, manufacturer's specifications, including materials description.
B. Performance data and curves, and horsepower requirements.
C. Outside utility requirements, such as water power, air, etc.
D. Functional description of any internal instrumentation and control supplied including list of parameters monitored, controlled, or alarmed.
E. Addresses and phone numbers of nearest service centers and a listing of the manufacturer's or manufacturer's representatives' services available at these locations, including addresses and phone numbers of the nearest parts warehouses capable of providing full parts replacement and/or repair services.
F. A list of five installations in the states where similar equipment by the manufacturer is currently in similar service; include contact name, telephone number, mailing address of the municipality or installation, engineer, owner, and installation contractor; if five installations do not exist, the list shall include all that do exist, if any.
G. Detailed information on site, architectural, structural, mechanical, plumbing, electrical, and control, and all other changes or modifications to the design and construction work necessary to adapt the equipment or systems to the arrangement shown and/or functions described on the drawings and in the technical specifications. This shall include plan view and section sketches illustrating any additional space requirements necessary to provide the minimum adequate clear space within and around the equipment for operation and maintenance, as shown on the drawings and specified.
H. All differences between the specifications and the proposed substitute equipment shall be clearly stated in writing under a heading of "differences".
I. Other specified submittal requirements listed in the detailed equipment and material specifications.
J. A completed and signed copy of the “Pump Station Certification Affidavit” which follows.

EVALUATION

Approval of the substitution to bid as an alternate shall in no way relieve the contractor from submitting the specified shop drawings for approval or complying fully with all provisions of the specifications and drawings.

If substituted equipment is accepted, the contractor shall, at his own expense, make any changes in the structures, piping, electrical, etc. necessary to accommodate the equipment. If engineering is required due to substitution of alternate equipment, the contractor shall pay for all engineering charges.

To receive final consideration, copies of the manufacturers' quotations for the equipment may be required to document the savings to the satisfaction of the engineer. It is the intent that the owner shall receive the full benefit of the savings in cost of equipment and the contractor's bid price shall be reduced by an amount equal to the savings. In all technical and other evaluations, the decision of the engineer is final.

STATION MONITORING PACKAGE

Pump overload trip alarm from starter overload trip
Time delay to prevent simultaneous pump starts
Phase failure/reversal monitor with pump motor shutdown on fault
Control power failure alarm

COLD CLIMATE PACKAGE

For cold weather operation, the station shall be provided with a 1300/1500 watt, dual range auxiliary heater with automatic circulating fan, thermostat control and an On/Off switch. The auxiliary heater shall be plugged into the station’s duplex receptacle. In addition, the fiberglass cover shall have a minimum of 1” thick urethane insulation, protected by fiberglass, with an “R” value of 7 or more. Also, the priming system shall be interlocked with the station temperature sensor so that, should the station ambient temperature fall below a pre-set minimum, solenoid valves shall open the priming system to atmospheric pressure, when the pumps are not running, allowing the liquid in the pumps and piping to drain back into the wet well, preventing freezing.

ENHANCED ALARM PACKAGE

A timer circuit shall be provided in the control panel to signal unauthorized entry into the pump station. The timer shall be activated whenever the fiberglass cover is opened. A key operated switch shall be provided on the station control panel to provide authorized personnel a means to deactivate the alarm before the timer completes its cycle. In addition to the High Water Alarm, the level control system shall be capable of indicating a Low Water Alarm. The station control panel shall also be provided with a maintained contact, manually operated, red mushroom head Emergency Stop Button in an easily accessible position on the top of the control panel to shut down the main pumps and remove power from the control circuits. Actuation of the switch shall also signal an alarm condition. This switch may also function as an emergency operator assist alarm, and provide means for testing the alarm system.

SECTION 1 - ALARM SENSORS

LOW WET WELL LEVEL ALARM

An adjustable displacement switch shall be provided to sense a low water level condition. The switch shall hang into the wet well and shall activate a contact to indicate the low water condition.

PHASE MONITOR

A relay with double pole, double throw contacts shall be provided to monitor and protect against phase loss (single-phasing), under voltage (brownouts) and phase reversal (improper sequence). It shall automatically reset when three-phase service returns to normal.

MOTOR CURRENT MONITORS

Motor current readings shall be displayed on separate panel mounted analog meters for each pump. Current transformers and associated circuitry shall be provided in the panel.

SINGLE-PHASE POWER MONITOR

A relay shall be provided to monitor the 120-Volt single-phase control power supply and initiate an alarm on loss of power. It shall automatically reset when the single-phase service returns to normal.

DEDICATED PUMP PRIME FAILURE

A time delay relay shall be connected to each vacuum pump. Contacts shall be provided to automatically shut down the operating vacuum pump, allow starting of the next pump in the operating sequence and signal an alarm on excessive vacuum pump operating time. Contacts shall be provided for transmitting an alarm signal.

OPERATOR ASSIST ALARM

The station control panel shall be provided with a maintained contact, manually operated, red mushroom-head Operator Assist Alarm Button in an easily accessible position on the control panel to signal emergency operator assistance is required. It also may be used to provide means for testing the alarm system.

UNAUTHORIZED ENTRY ALARM

A timer circuit shall be provided in the control panel to signal unauthorized entry into the pump station. The timer shall be activated whenever the fiberglass cover is opened. A key operated switch shall be provided on the station control panel to provide authorized personnel a means to deactivate the alarm before the timer completes its cycle.

SECTION 2 - ALARM INDICATORS

120V ALARM LIGHT

A vapor-proof light fixture with 50-watt lamp for outdoor pole mounting shall be provided with a red globe and guard.

120V ALARM LIGHT WITH FLASHER

A vapor-proof light fixture with 50-watt flashing lamp for outdoor pole mounting shall be provided. The light shall flash during alarm conditions. The fixture shall be complete with a red globe and guard.

120V ALARM BELL
A vibratone-type bell mounted on a weather-tight box suitable for pole mounting shall be provided.

120V ALARM HORN
A vibratone-type horn mounted on a weather-tight box suitable for pole mounting shall be provided.

12V TRICKLE CHARGER
Storage batteries and charger shall be supplied to furnish power for operating alarm annunciators in cases of power failure. The storage batteries (Two 3-cell, 6-volt) shall be maintenance-free lead-calcium battery concealed in high impact, heat-resistant and permanently sealed containers. The battery charger shall be solid-state, capable of restoring battery to full charge within 12 hours after a discharge, not exceeding 1.5 hours. Brownout protection is standard, and will activate the unit when AC line voltage drops below 85 volts.

12V ALARM LIGHT
A vapor-proof light fixture with 50-watt lamp for outdoor pole mounting shall be provided with a red globe and guard.

12V ALARM LIGHT WITH FLASHER
A vapor-proof light fixture with 50-watt lamp for outdoor pole mounting shall be provided with a red globe and guard. The light shall flash during alarm conditions.

12V ALARM BELL
A vibratone-type bell mounted on a weather-tight box suitable for pole mounting shall be provided.

12V ALARM HORN
A vibratone-type horn mounted on a weather-tight box suitable for pole mounting shall be provided.

REMOTE MOUNTED AUTOMATIC RESET ALARM SILENCE SWITCH
A momentary contact alarm-silencing switch mounted in a weatherproof box suitable for pole mounting shall be provided. The alarm shall automatically be reset when the alarm condition is removed.

PANEL MOUNTED AUTOMATIC RESET ALARM SILENCE SWITCH
A momentary contact alarm silencing switch mounted on the control panel shall be provided. The alarm shall automatically be reset when the alarm condition is removed.

PANEL MOUNTED MANUAL RESET ALARM SILENCE SWITCH
A manual alarm silencing switch mounted on the control panel shall be provided. The switch shall be manually reset when the alarm condition is removed.

REMOTE ALARM CONTACTS
In addition to the common, powered local alarm connection, individual unpowered contacts shall be provided and wired to a terminal strip for field connection to a remote alarm monitoring system (not included).

TEST UNIT WITH BATTERY FOR MULTI-SENSOR CHECK VALVE SWITCH [FOR USE WITH RELAY LOGIC CONTROLS.]
To test or set the multi-sensor check valve switches using the built-in LED light with Relay Logic control systems, a separate hand held battery pack with connecting cord and plug shall be provided. This is to enable the operator to accurately set the trip point of the switch manually, by means of the built-in test light on the multi-sensor.

DISCRETE CONTACTS FOR ALARM DIALER INTERFACE (DIALER NOT INCLUDED)
Provisions shall be made within the pump station to facilitate the field installation of an alarm dialer, which is to be furnished and installed by others. The alarm dialer shall be as described elsewhere in these specifications.
The factory built pump station shall be provided with a mounting bracket approximately 12 inches by 10-5/8 inches to attach

and support the alarm dialer, near the station control panel, beneath the fiberglass enclosure. In addition, openings for conduit connections shall be provided in the bottom of the station control panel and through the side of the station base, to facilitate wiring of the alarm dialer input, output and power connections. In addition to the powered common local alarm contact, the station control panel shall have terminal strip connections for fault-opening alarm contacts to provide up to 8 discrete alarm input signals (depending on the packages and options selected) to the dialer and shall also include terminal strip connections for a 1/60/120 volt power source, on a separate 15-amp circuit, to power the dialer. Wiring of the dialer shall be done by others during installation of the station in the field.

SECTION 3 - WET WELL ACCESSORIES

WET WELL FALL PROTECTION BARRIER

A fall protection safety barrier to prevent personnel, tools or equipment from falling through the manway opening and into the wet well when the manway cover is in the raised position, shall be provided by the station manufacturer for field installation in the wet well by the installing contractor. The fall protection barrier shall be constructed of aluminum bar grating and shall cover the area beneath the manway cover. Stainless steel hinges and a lifting handle shall be provided for convenience. When fully open, the fall protection safety barrier can be latched open for safe entering and exiting of the wet well. All components shall be constructed of stainless steel except for the aluminum grating. The barrier shall be capable of holding a 400-pound concentrated load, when in the Closed position.

The wet well fall protection barrier kit shall include the aluminum grating barrier, 304 SST hinges, 304 SST mounting brackets, 304 SST hardware, the required number of 1/2" diameter 304 SST wedge anchors for the specific wet well kit size and a complete set of instructions for installation of the fall protection barrier in a foot diameter wet well.

SECTION 4 - MECHANICAL

ADDITIONAL SPARE MECHANICAL SEALS

In addition to the one standard spare mechanical seal, additional spare mechanical seal(s) shall be provided. The spare seal(s) shall be packed in a suitable container and shall include complete installation instructions.

REMOVE FIBERGLASS ENCLOSURE

The fiberglass enclosure, station ventilating blower, and 500-watt electric heater shall not be provided.

REMOVE MANWAY ACCESS COVER

The aluminum treadplate manway access cover, stainless steel piano hinge and hardware shall not be provided.

EMERGENCY PUMPING CONNECTION

The common discharge pipe of the pump station shall be fitted with a branch with a [3"(75 mm), 4" (100 mm)] plug valve and male quick-connect fitting, with cap, as shown on the drawings, to facilitate connection of a portable emergency pump to the force main, to bypass the pump station. The emergency pumping connection shall be housed within the station's fiberglass cover.

SECTION 5 - CONTROL PANEL

MAIN CIRCUIT BREAKER

A main circuit breaker shall be installed in the control panel to provide over-current protection for the station, and shall be capable of being used to disconnect the three-phase power to the pump station.

The breaker shall be operable without opening the panel, and shall be interlocked with the panel door. It shall be capable of being padlocked in the "Off" position.

MAIN DISCONNECT SWITCH

A main disconnect switch shall be provided to disconnect the three-phase power to the pump station. The switch shall be operable without opening the panel, and shall be interlocked with the panel door. It shall be capable of being padlocked in the "Off" position.

TIME DELAY
The control system shall provide for a time delay to prevent simultaneously starting the pump motors after power failure.

GENERATOR INTERLOCK
Provisions shall be made in the control circuit of the lift station to facilitate locking out the standby pump when the emergency generator set is powering the station. An interlock consisting of a normally closed auxiliary contact shall be supplied with the emergency generator controls by the generator manufacturer. This normally closed contact shall be wired to the terminal blocks provided in the lift station control panel by the lift station manufacturer. The interconnecting wiring shall be supplied and connected by the installing contractor.

INTRINSICALLY SAFE CONTROL
Intrinsically safe relays to provide low current isolated switching for the float switches shall be provided.

NON-MERCURY FLOAT SWITCHES
The level control float switches shall be of the mercury free design, operated by a rolling steel ball traveling back and forth within a switch tube, to actuate a snap action switch, all mounted in a sealed plastic float housing, supported by a watertight cord. An integral weight shall cause inversion on submergence.

SOLID-STATE STARTERS
UL listed, solid-state reduced voltage starters shall be supplied. The starters shall be capable of a soft start and soft stop. The starters shall have built in overload protection as well as built in bypass contactors. One set of Form C auxiliary contacts shall be supplied on the starter. The starters shall have a built-in Digital Signal Processor utilizing a low impedance run circuit. The starters shall be easily programmable by using a standard screwdriver.

NEMA STARTERS
NEMA rated magnetic across-the-line starters with overload protection for each phase shall be provided for each pump motor to give positive protection against phase unbalance, thermal overload, phase loss and ground fault.

STAINLESS STEEL PANEL
The control equipment shall be mounted in a NEMA-type 4X stainless steel enclosure with two-section, piano hinged, lockable doors.

RUNNING TIME METER FOR PARALLEL OPERATION
A third running time meter shall be supplied to show the number of hours of operation with both pumps running in parallel. The meter shall be enclosed in a dust and moisture-proof molded plastic case. The flush mounted dial shall register in hours and tenths of hours up to 99,999.9 hours before repeating.
The meter shall be suitable for operation from a 115-volt, 60-cycle supply.

PUMP RUNNING LIGHTS
A green panel light to indicate “Pump On” shall be provided for each main pump.

BASE1-BASE2-AUTO ALTERNATE SELECTOR SWITCH
A 3-position selector switch shall be mounted on the face of the control panel to allow selection of either pump as the lead pump, or to allow for automatic alternation.

SURGE PROTECTIVE DEVICE
A surge protective device for lightning and surge protection with an internal automatic discharge circuit and rated for three-phase service shall be provided.

TIME DELAY
The pump control system shall provide for a time delay to prevent simultaneously starting the pump motors after power failure.

SEQUENTIAL ALTERNATION
In lieu of the timed alternation system, provisions shall be made to alternate the pumps at the completion of each pumping cycle.

EXTRA 20 AMPERE CIRCUIT BREAKER(S)
The main control panel shall contain spare 20 amp, single pole 120v circuit breaker(s) to power external equipment supplied by others.

ADD-A-PHASE INTERFACE
Terminals shall be provided in the lift station control panel to facilitate connection to an external Add-A-Phase phase converter unit.

ROTO PHASE INTERFACE
Terminals and a time delay to prevent simultaneously starting the pump motors after power failure shall be provided in the lift station control panel to facilitate connection to an external Roto Phase phase converter unit.

SECTION 6 - ENVIRONMENTAL

AUXILIARY STATION HEATER
A 1300/1500 watt, dual range, electric heater with automatic circulating fan, thermostat control and an On/Off switch is to be provided. The heater is to be operated by connection to the station convenience receptacle.

INSULATED HOOD
The fiberglass cover shall have a minimum of 1" thick urethane insulation, protected by fiberglass, with an "R" value of 7 or more.

SECTION 7 – MISCELLANEOUS

TOOLKIT
A metal toolbox complete with the following tools shall be provided. This complement of tools shall include all tools necessary to replace the pump mechanical seal.

9/16" x 1/2" Box End Wrench
3/4" x 5/8" Open End Wrench
15/16" x 1" Open End Wrench
1-1/8" Socket
8" T-Handle 11" x 1/2" Drive
1/2" x 5-1/2" Drive Extension
6" Pipe Wrench
#3 Rawhide Mallet
Ratchet-Type Hoist
Motor Lifting Bar
Lint-Free Cloth
Multi-Purpose Grease

450 JACK CARLEY CAUSEWAY

CITY OF MEMPHIS

SARP10 PROGRAM

DECEMBER 1, 2021
CONSTRUCTION DOCUMENTS

PREPARED BY: PICKERING FIRM, INC.

450 Jack Carley – Replaces Sections 15010 and 15150

SECTION 11310
WASTEWATER SUBMERSIBLE PUMPING STATION

PART 1 GENERAL

1.01 SCOPE

A. This section covers guide rail-mounted, vertical, single stage, submersible, non-clog, dual-simplex, end suction centrifugal pumping units.

B. Each pumping unit shall be complete with a close coupled, submersible, electric motor, guide rails; discharge base elbow with adapter; controls, access hatch cover; and all other appurtenances specified or otherwise required for proper operation.

1.02 REQUIREMENTS

A. Manufacturer's Qualifications

1. The pump manufacturer shall have a minimum of 25 units of similar type pumps installed and operating for no less than five (5) years in the United States.

2. All equipment approved for this project shall meet or exceed all performance, service, and warranty requirements of this specification.

3. The pumps shall be suitable for pumping raw sewage and shall be designed and fully guaranteed for this use. The fluid temperature range shall be from 40 to 115 degrees F.

B. Quality Control

1. Because of the critical service of the pump and its expected long service life it is mandatory that certain quality control procedures be followed during the manufacturing process.

2. The pump manufacturer shall perform, as a minimum, the following procedures and shall provide certification, at the time of shipment, that these have been performed.

3. A motor and cable insulation test for moisture content or insulation defects shall be made.

4. Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.

5. The pump shall be run for 30 minutes submerged, a minimum of 6 feet under water.

6. After the submerged operational test, the insulation test is to be performed again.

1.03 RELATED SECTIONS

A. Section –02530 – Sewer Pipe Installation

1.04 SUBMITTALS

A. Complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications, and data covering materials used, parts, devices, and other accessories forming a part of the equipment furnished, shall be submitted in accordance with the submittals section. The data and specifications for each unit shall include, but shall not be limited to, the following:

1. Pumps
   a. Name of manufacturer.
   b. Type and model.
   c. Rotative speed.
   d. Size of discharge nozzle.
   e. Size of discharge elbow and adapter inlet and outlet.
   f. Type of bearings.
   g. Net weight of pump and motor only.
   h. Complete performance curves showing capacity versus head.
   i. NPSH required, efficiency, and KW input.
   j. Data on shop painting.

2. Motors
   a. Name of manufacturer.
   b. Type and model.
   c. Type of bearings and lubrication.
   d. Rated size of motor, hp.
   e. Temperature rating.
   f. Full load rotative speed.
   g. Net weight.
   h. Efficiency at full load and rated pump condition.
   i. Full load current.
   j. Locked rotor current.

3. Control Panel and Components
   a. Name of Manufacturer.
   b. Type and model.
   c. Dimensions and net weight of complete panel.
   d. Overcurrent characteristics and details of motor control.

1.05 SITE POWER SUPPLY:

A. 120/208 volts, 3 phase, 60 hertz.

PART 2 PRODUCTS

2.01 PUMPS

A. Manufacturers: NA

B. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer. Definition of terms and other hydraulic considerations shall be as set forth in the Hydraulic Institute Standards.

C. Service Conditions: Each pumping unit shall be designed to handle raw sewage. Each pumping unit will be installed in an existing concrete wet well. Each pumping unit shall be capable of operating under load in both a dry pit installation and a totally submerged environment, without

damage. Motors shall be sufficiently cooled by the surrounding environment so that a cooling jacket is not required. Each pumping unit shall be designed for continuous duty handling pumped media of 40C and capable of handling a maximum of 15 evenly spaced starts per hour.

D. Performance and Design Requirements: Pumping units shall be designed for the following operating conditions and requirements:

1.	Number of units:	2
2.	Rated total head:	45 feet
3.	Capacity at rated:	80 gpm
4.	Operating head range:	11-17 feet
5.	Max pump operating speed:	2300 rpm
6.	Min motor hp rating:	5.5
7.	Min discharge elbow outlet size:	4 inches
8.	Min hydrostatic test pressure:	1.5 x shut-off head
9.	Phase:	3
10.	Hertz:	60
11.	Voltage:	230

E. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences. The design running clearance between the impeller inlet and the casing wearing ring (if provided) shall be not less than 0.006 inch or one-half mil per inch of casing wearing ring diameter, whichever is greater.

F. Each pumping unit shall be designed so that reverse rotation at rated head will not cause damage to any component.

2.02 MATERIALS

A.	Stator Housing, Oil Chamber Housing, and Sliding Bracket	Cast Iron, ASTM A48, Class 35B
B.	Casing Insert Ring & Impeller chrome cast iron)	Hard-Iron™ (ASTM A-532 (Alloy III A) 25%
	Shaft	Stainless Steel, AISI Type 431.
C.	All Wetted Assembly Fasteners	Stainless Steel, AISI Type 316
D.	Mechanical Seals	2 Tandem Type, oil lubricated.
1.	Lower and Upper Seals points.	Corrosion Resistant Tungsten carbide at all
2.		
E.	Discharge Base	Cast iron ASTM A48, Class 35B
F.	Guide Rails	Stainless Steel pipe, AISI 304ss Schedule 40
G.	Anchor Bolts, Nuts and Washers	Stainless Steel

H. Epoxy Coating

1. Two Coats All castings must be blasted before coating. All wet surfaces are to be coated with two-pack oxyrane ester Duasolid 50. The total layer thickness should be at least 120 microns. Zink dust primer shall not be used.

2.
3.

2.03 PUMP CONSTRUCTION

A. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of nitrile rubber O-rings without requirement of a specific torque limit. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

B. Impeller: The impeller blades shall be self-cleaning upon each rotation as they pass across a sharp relief groove in the Insert ring and shall keep the impeller blades clear of debris. The insert ring shall have a guide pin which moves fibers from the center of the impeller to the leading edges of the impeller. The impeller shall move axially upwards to allow larger debris to pass through and immediately return to normal operating position. The clearance between the insert ring and the impeller leading edges shall be adjustable. Due to the likely presence of sand and or grit the impeller and the cutting ring shall be made of ASTM A-532 Alloy III A with 25% chrome. Impellers that have surface hardening or coating will not be allowed.

C. Volute & Insert Ring: The pump volute shall be a single piece gray cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. Due to the likely presence or sand or grit the insert ring shall be cast of Hard-Iron™ ASTM A-532 Alloy III A 25% chrome cast iron and provide effective sealing between the multi-vane semi-open impeller and the volute housing.

D. Motor: The pump shall be operated by a synchronous motor and an integrated control system and be capable to run at constant power at any point of the performance field without being overloaded. Motor shall utilize a permanent magnet rotor to maintain synchronous speed and maintain level IE-4 premium efficiency standards. The motor shall withstand at least 60 starts per hour. The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of pins, bolts, screws or other fastening devices used to locate or hold the stator and that penetrate the stator housing are not acceptable. The motor shall be designed for continuous duty while handling pumped media of up to 104°F.

E. Integrated Control: An integrated pump control system installed in the pump/motor housing shall ramp up the speed at start-up of the pump to reduce the start-up current and secure that the direction of the impeller rotation is always correct. There shall be no need for any human intervention to ensure that the impeller is rotating in the correct direction within the volute. The control system that is integrated within the pump/motor housing shall be encapsulated to protect it against moisture ingress, and vibration. Motor, pump and control system shall be designed and produced by the same manufacturer. The integral control system mounted within the pump/motor housing shall be capable of adjusting the motor/impeller speed so that the pump can safely operate without overloading anywhere within the pumps' operating envelope. The pump shall incorporate a "pump-cleaning" function to remove debris from the impeller. The cleaning

function shall be initiated when the integral control system senses an increase in current draw due to debris in the pump. The cleaning function shall consist of forced stopping, reversal and forward runs timed to allow for debris to fall from the impeller. After cleaning cycle is complete, the pump shall resume to automatic operation. If the pump impeller/volute does not clear itself after the programmed number of attempts, the control will initiate and alarm to notify that the pump inlet / volute is blocked by large debris.

F. Shaft & Bearings: The AISI 431 SS shaft shall rotate on two bearings. The motor bearings shall be sealed and permanently grease lubricated with high temperature grease. The upper motor bearing shall be a single row ball bearing to handle radial loads. The lower bearing shall be a double row angular contact ball bearing to handle the thrust and radial forces. Single row lower bearings are not acceptable. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump performance field.

G. Oil Chamber Housing: The oil chamber shall contain a moisture sensor, inspection plug, drain plug and vent plug.

H. Mechanical Seals: Each pump shall be provided with a positively driven dual, tandem mechanical shaft seal system consisting of two seal sets, each having an independent spring. The lower primary seal, located between the pump and seal chamber, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide ring. The upper secondary seal, located between the seal chamber and the seal inspection chamber shall be a leakage-free seal. The upper seal shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. The rotating seal ring shall have small back-swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber. All seal rings shall be individual solid sintered rings. Each seal interface shall be held in place by its own spring system. The seals shall not depend upon direction of rotation for sealing. Mounting of the lower seal on the impeller hub is not acceptable. Shaft seals without positively driven rotating members or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces are not acceptable. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance.

I.

J. Sealing of Mating Surfaces: All mating surfaces of major components shall be machined and fitted with 0-rings where watertight sealing is required. Sealing shall be accomplished by O-ring contact on four surfaces and O-ring compression in two planes without reliance on a specific fastener torque or tension to obtain a watertight joint. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain gasket or seal compression and water tightness will not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints will not be acceptable.

K. Discharge Base: A discharge base and discharge elbow shall be furnished by the pump manufacturer for each pumping unit. The base shall be sufficiently rigid to firmly support the guide rails, discharge piping, and pumping unit under all operating conditions. The base shall be provided with one or more integral support legs or pads suitable for bolting to the floor of the wetwell. The face of the discharge elbow inlet flange shall be perpendicular to the floor and make contact with the face of the pump discharge nozzle flange. The diameter and drilling of the elbow outlet flange shall conform to ANSI B16.1, Class 125.

1. The pump and motor assembly shall be automatically connected to and supported by the discharge base and guide rails such that the unit can be removed from the surge basin and replaced without the need for operating personnel to enter the surge basin.

L. Sliding Bracket: Each pumping unit shall be provided with an integral, self-aligning guide rail sliding bracket. The bracket shall be designed to obtain a wedging action between flange faces as final alignment of the pump occurs in the connected position. The bracket shall maintain proper contact and a suitably sealed connection between flange faces under all operating conditions.

M. Guide Rails: Each pumping unit shall be equipped with one or more guide rails constructed of stainless steel pipe. Guide rails shall be sized to fit the discharge base and the sliding bracket and shall extend upwards from the discharge base to the access hatch cover at the top of the surge basin. An upper guide rail bracket shall be provided and shall be stainless steel.

N. Lifting Cable or Chain: A cable or chain suitable for removing and installing each pump shall be selected and provided by the pump manufacturer. The cable or chain shall be 316 stainless steel. A suitable cable or chain hook shall be provided at the top of the surge basin.

O. Access Hatch Cover: Each access hatch cover shall be provided by the pump manufacturer. Each cover all be of all aluminum construction and suitable for a live load of 150 pounds per square foot. The cover shall be a double leaf type constructed of structural shapes and reinforced diamond pattern checkered plate. Structural shapes and plates shall have a thickness of not less than 1/4 inch. Each leaf shall be provided with two hinges, torsion bars or other device to assist opening, an automatic hold open arm, retractable handle, and a padlock hasp. The frame shall be provided with either strap anchors bolted or welded to the exterior, or a continuous anchor flange. All aluminum surfaces to be in contact with concrete or mortar shall be given a heavy coat of coal tar paint.

1. Each cover shall be provided with a lifting cable or chain hook, a guide rail support bracket, and a support bracket for the level control float cables.

2.04 CONTROLS

A. Liquid Level Sensor: The sump shall be equipped with a Multi-Stage Level Sensing Device or a Level transmitter designed to detect level of the waste water for pump control and liquid level display. The Multi-Stage Level Sensing Device shall be PVC injected to seal the unit and prevent any moisture from entering any of the sensor units. Each sensor on the probe shall be rotated 90 degrees horizontally from the previous sensor along the probe length to eliminate tracking between sensors. Level sensing probes shall be pressure injected with an epoxy resin at final assembly to encapsulate all internal components and connections, thereby creating a rigid, sealed, homogeneous unit. Two wires shall be included within the length of the probe and shall be connected to each other at the bottom of the probe. When the wires are connected to the Pump station Controller, the connection shall provide fail-safe monitoring of the probe cable and the probe assembly.The flexible cable used for the Level Sensing Probe shall be comprised of PVC/PVC multi-conductor construction with a common oversheath that is water and oil resistant. The multi-conductor cable shall be identified with numbering and text along the entire length of the outer sheath at required intervals. The Level transmitter shall measure the relative pressure with a ceramic diaphragm and be approved acc. EN

61000-6-2, EN 61000-6-3, EN 61326-1. It shall be insulated > 100 MΩ at 500 V DC and the sensor body shall be made of Ryton PPS. All sensors installed in the sump shall be approved for explosive areas according UL Class 1, 2 and 3 Division 1 Group A-D T4/T5/T6. Cables shall be secured to the top of probe bodies by synthetic rubber compression fittings for strain relief. The cable shall be rated to physically support the combined weight of the sensor and long enough to reach to reach the cable connection box. The mounting bracket shall be by stainless steel and include a wiper device that allows maintenance personnel to clean the level sensing probe when necessary.

B.

C. Pump Controls: Pumps No. 1 and No. 2 shall operate in an automatic dual-simplex mode alternating lead pump and lag pump. Standby pump shall start and lead pump shall stop if liquid level rises to standby pump on elevation. All controls shall be mounted in a NEMA 4X enclosure mounted on Unitstrut metal channel framing adjacent to the pump station. Float switch operation shall provide the following functions during rising and falling levels in wetwell:

1. Low level shut-off and alarm shutdown of all pumps.
2. Normal low-level pump off. (Pumps No. 1 and No. 2.)
3. Lead pump start.
4. Lag pump start at high level. (Pumps No. 1 and No. 2)
5. High liquid level alarm.

D. Operation: Systems design shall provide that pumps No. 1 and No. 2 shall alternate as lead and lag pumps at normal low-level pump off elevation. When pump failure should occur, operation shall automatically start the opposite pump immediately and at the same speed as the failed pump. The lag pump shall operate as lead pump until failed pump has been repaired and placed back in service. Failure of either pump shall be indicated by a light on the control panel indicating the problem and energizing the flashing alarm.

1. Branch Circuit Disconnects:
   a. Disconnect Switches: A thermal magnetic air circuit breaker for each pump motor shall be adequately sized to meet the pump motor operating conditions and sealed by the manufacturer after calibration to prevent tampering. A mechanical disconnect mechanism shall be installed on each circuit breaker as a means of disconnecting power to the pump motors. The disconnect mechanism operator handles shall be lockable, located on the exterior of the control enclosure and permit the door to open only when the circuit breakers are in the "OFF" position.
2. Station Optimization: The following station optimization features shall be pre-configured:
   a. Fat buildup minimization feature that uses a random lead pump start delay timer. The timer shall be initially set to 60 seconds.
   b. A sump and pipe cleaning function that will run the CPS to the snore point based on an operator configurable number of pump cycles. The number of cycles shall be initially set to 11.
   c. The system shall automatically detect a blockage and automatically clear the blockage. The station controller shall monitor the status and annunciate an alarm should the blockage not be cleared.
   d. The station controller shall have an energy minimizer function that minimizes the amount of energy used per pumping cycle.
   e. Integrated data logger with:
      i. Capacity for recording up to 4,000 events and ability to download events to a USB storage device

f. Faults on the controller shall be configurable for:
   i. Acknowledgement Required
   ii. Three (3) levels of priority
   iii. Automatically resetting fault

3.

4. Overload Protection: The system shall monitor motor current and shall trip in the event that the motor current at the rated voltage exceeds the setpoint. The System shall monitor temperature of the motor, power level, and speed.

5. Pump Motor Protection: The pump control panel shall be equipped to terminate pump operation due to high motor winding temperature or moisture in the motor housing and shall utilize the contacts in the pump motor. If either event should occur, the motor cease to operate and an indicator, visible on the inner door and pilot light visible on the outer door, shall indicate the pump motor has been shut down due to thermal overload or moisture. The pump motor shall automatically reset when the condition has been corrected. Manual reset shall be required on Critical Faults.

6. Phase Monitor: The control panel shall be equipped to monitor the incoming power and shut down the pump when required to protect the motor(s) from damage caused by phase reversal, phase loss, voltage unbalance greater than 5% or voltage less than 83% of nominal. A time delay shall be provided to minimize nuisance trips. The motor(s) shall automatically restart when power conditions return to normal.

7. Secondary Surge Arrester: 480VAC three phase surge suppression device shall be installed in line with the supply voltage with the following features:
   a. Each input shall have a nominal AC operating voltage of 240V for 240V supply or 277V for 480V supply
   b. Meet UL 1449 4th edition requirements
   c. Meet IEC 61643-11 requirements
   d. Response time <1ms
   e. Nominal discharge current: 20kA 8/20 µs
   f. Maximum discharge current: 50kA 8/20 µs
   g. Maximum surge capacity: 60kA 8/20 µs
   h. Voltage protection rating: 1000V (240V) or 1500V (480V)
   i. Voltage protection level: 1300V (240V) or 1700V (480V)
   j. Residual voltage at 10kA (8/20 µs): 1395V
   k. Operating frequency range: 0-500Hz
   l. Operating temperature: -40ºC to +85ºC

8.

9. Pump Start Delay: The control circuit for one of the pumps shall be equipped with a time delay to prevent simultaneous motor starts following a power outage. The time delay shall be a solid state fixed 5 second on-delay device.

10. High Liquid Level Alarm and Silencer: In the event the high liquid alarm level in the wetwell is reached, a signal relay equipped with one set of normally open (N.O.) contacts shall be energized, the N.O. controls shall then close and complete a 115 volt AC circuit for the external alarm signal devices. The signal relay shall include an indicator visible on the front of the control enclosure and shall maintain the alarm signal until manually reset. The external signal devices shall be silenced by a momentary actuation of the alarm silence switch which shall energize an alarm silence relay. After lowering the high liquid level and manually resetting the signal relay, the alarm silence relay shall drop out, requiring no further attention by the operator.

11. Low Liquid Level Alarm and Silencer: In the event the liquid level in the wetwell is reduced to a minimum depth of 12 inches, a low liquid level alarm shall be activated. Upon activation, a signal relay equipped with one set of normally open (N.O.) contacts shall be energized, the N.O. controls shall then close and complete a 115 volt AC circuit for the external alarm signal devices. The signal relay shall include an indicator visible on the front of the control enclosure and shall maintain the alarm signal until manually reset. The external signal devices shall be silenced by a momentary actuation of the alarm silence switch which shall energize an alarm silence relay. After raising the low liquid level and manually resetting the signal relay, the alarm silence relay shall drop out, requiring no further attention by the operator. The alarm shall not actuate on the 10^{th} cycle intentional pump down of the wet well.

12. Pump Run Lights: Each pump motor shall have a pilot light located in the front of the control enclosure which shall illuminate when the motor is running.

13. Elapsed Time Meters: An elapsed time meter for each pump motor shall be mounted in the front of the control enclosure and wired to each motor starter to record total running time of each pump motor in hours and tenths of hours. The elapsed time meter shall be 6-digit, nonresettable.

14. Pump Sequence Selector: A 3-position toggle switch shall be provided which shall override the automatic alternator and provide manual selection of either pump No. 1 or No. 2 as the "lead" pump.

15. Pump Mode Selector: The pump mode selector switch shall be a three (3) position "HAND-OFF-AUTO" type for each pump. In the "AUTO" mode the pump is operated automatically by the controls. In the "OFF" mode the pump will not operate, and in the "HAND" mode the pump will operate continuously without regard to automatic controls.

16. Enclosures: All controls shall be mounted in a NEMA 4X watertight enclosure.

    a. Receptacle: A duplex ground fault indicating utility receptacle providing 115 VAC, 60 Hertz, single phase current, shall be mounted through the inner swing panel of the control enclosure. Receptacle circuit shall be protected by a 15 ampere thermal-magnetic circuit breaker.

    b. Panel Heater: The control panel shall be equipped with a panel heater to minimize the effects of humidity and condensation. The heater shall include a thermostat.

    c. Auxiliary Power Transformer: The pump control panel shall be equipped with a 500 KV stepdown transformer to supply 115 volt, AC, single phase for the control and auxiliary. The primary side of the transformer shall be protected by a thermal magnetic air circuit breaker, specifically sized to meet the power requirements of the transformer. A mechanical operating mechanism shall be installed on the circuit breaker to provide a means of disconnecting power to the transformer. The operator handle for the mechanism shall be located on the exterior of the control panel, with interlocks which permit the door to be opened only when the circuit breaker is in the “OFF” position.

17. Alarm Light: The alarm light shall be 115 volt AC, 100 watt, vaportight type with a red globe, guard and mounting hardware. The alarm light shall be located and wired as shown on the drawings. The alarm light circuit shall be equipped with a repeat cycle timer causing the alarm light to flash at approximately 1 second cycles (½ second on and off).

2.05 BALANCE

A. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the vibration displacement (peak-to-peak) as measured at any point on the machine shall not exceed 4.0 mils.

B. At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

2.06 ELECTRIC MOTORS

A. The motor and the pump control system shall receive sufficient cooling from the pumped liquid to operate the pump at continuous duty in a liquid with a temperature with 104°F. Operational restrictions on the liquid temperature below 104°F or the demand of auxiliary cooling systems like fans or blowers are not acceptable. The Stator shall be inverter duty rated in accordance with NEMA MG1, Part 31 and be insulated according class H (356°F).

B. Motor, pump and control system shall be designed and supplied by the pump manufacturer.

C. The control system shall continuously monitor the leakage sensor in the stator housing and the temperature of the motor. It shall be impossible to overload the motor. If the motor temperature is too high, the pump shall continue to operate at reduced power until conditions are normalized. External trips or overload devices for motor protection shall not be required.

D. The operator shall be able to modify the setting of the control system to decide if the active leakage signal shall stop or not stop the pump.

E. The pump shall incorporate a “pump-cleaning” function to remove debris from the impeller. The cleaning function shall be initiated when the integral control system senses an increase in current draw due to debris in the pump. The cleaning function shall consist of forced stopping, reversal and forward runs timed to allow for debris to fall from the impeller. After cleaning cycle is complete, the pump shall resume to automatic operation. If the pump impeller/volute does not clear itself after the programmed number of attempts, the control shall initiate and alarm to notify that the pump inlet / volute is blocked by large debris.

F. It shall be possible to access and adjust the pump system with a Human Machine Interface (HMI) ranging from basic monochrome displays to full-color touch screen units and smartphone or tablet. It shall enable the operator to view and control entire pump system and logged operational data like number of starts, avoided clogging instances, pump run-time, motor power, motor current, power factor, temperature, pump leakage etc.

A. Each pump motor shall be provided with a shielded cable suitable for submersible pump applications; this shall be indicated by a code or legend permanently embossed on the cable. The cable shall be not less than 50 feet in length. Cable sizing shall conform to NEC requirements.

B. The cable entry water seal design shall be such that a specific fastener torque is not required to ensure a watertight and submersible seal. The use of epoxies, silicones, or other secondary sealing systems will not be acceptable. The cable entry junction box and motor shall be separated by a stator lead sealing gland or terminal board. The junction box shall isolate the motor interior from moisture gaining access through the top of the stator housing or a separate moisture sensing device shall be provided in the stator housing.

2.07 SPARE PARTS -

A. A complete set of seals, O-rings, gaskets, and one spare mechanical seal set, consisting of an upper and lower seal, shall be furnished for each pump.

B. Stipulations, with labels indicating the contents of each package. Spare parts shall be delivered to the Owner as directed.

2.08 PAINTING

A. All castings must be blasted before coating. All wet surfaces are to be coated with two-pack oxyrane ester Duasolid 50. The total layer thickness should be at least 120 microns. Zink dust primer shall not be used.
B. Stainless Steel parts shall not require coatings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Each discharge base shall be leveled, plumbed, aligned, and wedged into position to fit connecting piping. Installation procedures shall be as recommended by the pump manufacturer and the Hydraulic Institute Standards. Grouting shall be as specified in the grouting section.

B. Anchor bolts shall be accurately located and centered in pipe sleeves having an inside diameter approximately 2-1/2 times the bolt diameter and with a length approximately 8 times the bolt diameter.

END OF SECTION

5175 JONETTA STREET

CITY OF MEMPHIS

SARP10 PROGRAM

DECEMBER 1, 2021
CONSTRUCTION DOCUMENTS

PREPARED BY: PICKERING FIRM, INC.

SECTION 15150

DUPLEX SUBMERSIBLE PUMPING SYSTEM DESIGN REQUIREMENTS

PART 1 – PERFORMANCE

Submersible pumps shall meet the following performance requirements:

Item (Units)	**60 Hertz Operation**
Primary Duty Point (GPM/ft.)	435 GPM@ 85' TDH
Minimum Shutoff Head (ft.)	Per Manufacturer Specs
Maximum Specific Energy at Primary Duty Point (KWHr/MG)	437 KWHr/MG
Min Motor Rating (HP) at 40 degrees C	20 HP @ 40° C
Maximum NPSHre (ft) for AOR	33 Feet
Voltage/Cycle/Phase	230/60Hz/ 3Phase
Motor Design Type	NEMA Class B, NEMA MG1, Part 31 Rated
Motor Service Factor	Greater than 1.10
Motor Insulation Rating	Class H
Maximum Rated Current (A)	8.7 Amps
Minimum Pump Discharge Connection Size (inches)	4"

Revised from 15 to 20 HP

PART 2 – EQUIPMENT

2.01 PUMP DESIGN (Wet Well Mounted)

The pump shall be capable of handling raw, unscreened sewage. The discharge elbow shall be permanently installed in the wet well along with the discharge piping. The pumps shall be automatically connected to the discharge connection elbow when lowered into place. Pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be removed for the purpose and no need for personnel to enter the pump well. Sealing of the pumping unit to the discharge elbow shall be accomplished by a simple linear downward motion of the pumps with the entire weight of the pumping units guided to and pressed tightly against the discharge elbow with a metal-to-metal watertight contact. Sealing of the discharge interface by means of a diaphragm, O-ring or other device will not be acceptable. No portion of the pump shall bear directly on the floor of the sump, and there shall be no more than one 90-degree bend allowed between the volute discharge flange and sump piping. Guide bars, which shall steer the pump into proper contact with the discharge elbow shall be non-adjustable and shall not bear the weight of the pump.

2.02 PUMP CONSTRUCTION

Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel or brass construction. All metal surfaces coming into contact with the

5730 SARANAC AVENUE

CITY OF MEMPHIS

SARP10 PROGRAM

DECEMBER 1, 2021
CONSTRUCTION DOCUMENTS

PREPARED BY: PICKERING FIRM, INC.

FOR REFERENCE – SEE PLANS FOR PROJECT REQUIREMENTS

SECTION 11310 – WET WELL MOUNTED PUMP STATION WITH DUPLEX NON-CLOG PUMPS

GENERAL

The contractor shall furnish and install one factory-built, automatic pumping station as manufactured by Smith & Loveless, Inc., or approved equal. The station shall be complete with all needed equipment, factory-installed on a welded steel base with a hinged fiberglass cover.

The principal items of equipment shall include two vertical, close-coupled, motor driven, vacuum primed, non-clog pumps; valves; internal piping; central control panel with circuit breakers; motor starters and automatic pumping level controls; heater; ventilating blower; priming pumps with **SONIC START®** pump prime detection system and appurtenances; and all internal wiring.

OPERATING CONDITIONS

Each pump shall be capable of delivering * GPM (l/s) of raw water or wastewater against a total dynamic head of * feet (m). The minimum acceptable pump efficiency at this condition shall be 51%. Due to the energy conservation requirements, the minimum efficiency will be enforced. The maximum allowable speed shall be * RPM. The minimum rated horsepower (kw) of each pump motor shall be * . The actual static suction lift, measured from the station baseplate to the "off" level in the wet well, shall be 21.0' (m) at *' (m) elevation above Mean Sea Level. The pumps shall be capable of meeting or exceeding this value, at the specified altitude.

The minimum specified pump efficiency is _%. Should a Contractor wish to propose an alternate pump which does not meet or exceed the specified efficiency, the Contractor will be required to provide, 15 days prior to the bid opening, a pre-bid submittal packet with the proposed pump details, pump curve and efficiency. The submittal will be accompanied by a 25 year cost of operation difference calculation. The energy cost difference, due to reduced efficiency, over a 25 year period, calculated at $** per KWH, shall be applied as an adder when evaluating the alternate manufacturer's bid number.

All openings and passages shall be large enough to permit the passage of a sphere 3" (75 mm) in diameter and the pump shall have a flanged suction and discharge connection no smaller than 4" (100 mm). The anticipated operating head range is from * feet (m) minimum to * feet (m) maximum. The pump motors shall not be overloaded beyond their nameplate rating at the design conditions nor at any head in the operating range.

*- Refer to Design Drawings for Pump Data at each site.
**- Refer to standard power rates per Memphis Light Gas and Water Division

CONSTRUCTION

The station shall be constructed in one complete, factory-built assembly. It shall be sized to rest on the top of the wet well as detailed in the construction drawings.

A. EPOXY COATED CARBON STEEL BASEPLATE

The supporting floor plate shall be minimum [3/8" (9.5 mm), ½" (13 mm), 1" (25 mm)] thick carbon steel with reinforcing, as required, to prevent deflection and ensure an absolutely rigid support. Steel plate shall meet or exceed ASTM A-36 specifications.

WELDING

All steel structural members shall be joined by electric arc welding with welds of adequate section for the joint involved. Structural welding shall be preformed in accordance with AWS standards and procedures.

PROTECTION AGAINST CORROSION

All structural steel surfaces shall be factory blasted with steel grit, in an environmentally controlled booth, to remove rust, mill scale, weld slag, etc. All weld spatter and surface roughness shall be removed by grinding. Surface preparation shall comply with SSPC-SP6 specifications. Sandblasting is specifically prohibited.

Immediately following cleaning, a single 6-8 mil (0.15-0.20 mm) dry film thickness coating of VERSAPOX®, a self-priming

Cycloaliphatic Amine Epoxy shall be factory applied to the base. After curing, a 2-3 mil (0.05-0.08 mm) DFT top coating of XTRATHANE™, a moisture-cured Aliphatic Polyurethane protective finish, for abrasion resistance and weather protection, shall be applied to the top of the base. These coatings shall be as formulated by Smith & Loveless specifically for this type of application and service.

Stainless steel, aluminum and other corrosion-resistant surfaces shall not be coated. Carbon steel surfaces not otherwise protected shall be coated with a suitable non-hardening rust preventative compound. Auxiliary components such as the electrical enclosure, ventilating blower and vacuum pumps shall be furnished with the original manufacturer's coating.

Finish coating shall be accomplished prior to shipment of the station from the factory and shall comply fully with the intent of these specifications. A touch-up kit shall be provided by the pump station manufacturer for repair of any mars or scratches occurring during shipping and installation. This kit shall contain detailed instructions for use.

MAIN PUMPS

The pumps shall be 4" vertical, centrifugal non-clog type of heavy cast-iron construction, especially designed for the use of mechanical seals and vacuum priming. In order to minimize seal wear caused by linear movement of the shaft, the shaft bearing nearest the pump impeller shall be locked in place so that endplay is limited to the clearance within the bearing. To minimize seal wear resulting from shaft deflection caused by the radial thrust of the pump, the shaft from the top of the impeller to the lower bearing supporting the impeller shall have a minimum diameter of 1-7/8" (48 mm) for motor frame sizes 213 through 286; 2-1/8" (54 mm) for motor frame sizes 324 and 326; and 3" (76 mm) for frame 364 and larger. The dimension from the lowest bearing to the top of the impeller shall not exceed 6" (152 mm). The motor shaft shall be directly connected to the impeller without the use of drive belts or couplings, which require alignment and maintenance, and which increase power consumption due to their inherent energy losses.

Pumps with less than a standard 4" (100 mm) suction or 4" (100 mm) discharge connection, or with less than a 3" (76 mm) spherical solids handling capacity will be rejected for this application.

The oversized shaft incorporating oversized bearings and heavier bearing frame construction provides for extended mechanical seal, bearing and overall pump/motor life. Since the larger shaft with the specified minimum overhang is the key to heavier, more rigid construction throughout, no deviation from the specified shaft diameter or tolerances will be allowed.

The bearing nearest the impeller shall be designed for the combined thrust and radial load. The upper bearing shall be free to move in a linear direction with the thermal expansion of the shaft and shall carry only radial loads.

The shaft shall be solid stainless steel through the mechanical seal to eliminate corrosion and abrasive rust particles. Removable shaft sleeves will not be acceptable if the shaft under the sleeve does not meet the specified minimum diameter.

The pump shall have an integral adapter providing a large water reservoir above the impeller to provide for positive exclusion of air from the impeller. The seal shall be inside this area to assure lubrication. Pumps which do not use hollow priming adapters for positive lubrication of the seal will not be acceptable. Self-priming pumps are specifically unacceptable due to the need for suction check valves, air vent piping and the possibility of overheating and damaging the pump or producing steam or high temperatures in the pump, which may be a hazard to the operator, when the pump is run dry.

The pump controls must be set so that the main pumps cannot be turned on unless they are filled with liquid, and the pump is completely primed.

The pump shall be constructed so as to permit priming from the lower pressure area behind the impeller. Priming from high-pressure connections, which tends to cause solids to enter and clog the priming system, will not be acceptable. The priming bowl shall be transparent, enabling the operator to monitor the priming level.

The pump shall be arranged so that the rotating element can easily be removed from the casing without disconnecting the electrical wiring or disassembling the motor, impeller, backhead or seal, so that any foreign object may be removed from the pump or suction line. Enclosed impellers must be used to avoid the necessity of wear plates and the associated costs of replacement and maintenance of wear plate clearances with semi-open impellers.

The pump shaft shall be sealed against leakage by a single mechanical seal constructed so as to be automatically drained and primed each time the pump is drained and primed. Water, which lubricates the mechanical seal, shall be automatically drained

from around the seal if the pump loses prime in order to allow both the pump and the seal to be drained, thereby preventing freezing and breakage of the seal during power outages in sub-freezing temperatures.

The seal shall be of carbon and ceramic materials with the mating surfaces lapped to a flatness tolerance of one light band. The rotating ceramic shall be held in mating position with the stationary carbon by a stainless steel spring. The entire seal assembly shall be held in place by a bronze seal housing to prevent excessive heat buildup. Use of cast-iron or other ferrous material for the seal housing which will rust and damage the seal, shortening its life, will not be acceptable.

The pump volute shall be furnished with mounting lugs and bolted to the station floor plate, forming a gas-tight seal.

A. NON-CLOG TWO-PORT IMPELLER (4" & 6" PUMP OPTION) [(100 & 150 MM PUMP OPTION)]

The pump impeller shall be of the enclosed two-port type made of close-grained cast-iron and shall be balanced. The eye of the impeller as well as the ports shall be large enough to permit the passage of a sphere 3" (76 mm) in diameter in accordance with nationally recognized codes. The impeller shall be keyed with a stainless steel key and secured to the motor shaft by a stainless steel capscrew equipped with a Nylock or other suitable self-locking device. The impeller shall not be screwed or pinned to the motor pump shaft and shall be readily removable without the use of special tools. To prevent the buildup of stringy materials, grit and other foreign particles around the pump shaft, all impellers less than full diameter shall be trimmed inside the impeller shrouds. The shrouds shall remain full diameter so that close minimum clearance from shrouds to volute is maintained. Both the end of the shaft and the bore of the impeller shall be tapered to permit easy removal of the impeller from the shaft.

MOTORS

The pump motors shall be vertical, solid shaft, NEMA P-base, squirrel-cage induction type, suitable for 3 phase, 60 cycle, 230 volt electric current.

They shall have Class F insulation. Insulation temperature shall, however, be limited to Class B. The motors shall have normal starting torque and low-starting current, as specified by NEMA Design B characteristics. They shall be open drip-proof design with forced air circulation by integral fan. Openings for ventilation shall be uniformly spaced around the motor frame. Leads shall be terminated in a cast connection box and shall be clearly identified.

The motors shall have 1.15 service factor. The service factor shall be reserved for the owner's protection. The motors shall not be overloaded beyond their nameplate rating, at the design conditions, nor at any head in the operating range as specified under Operating Conditions.

The motor-pump shaft shall be centered, in relation to the motor base, within .005" (0.127 mm). The shaft runout shall not exceed .003" (0.076 mm).

The motor shaft shall equal or exceed the diameter specified under Main Pumps at all points from immediately below the top bearing to the top of the impeller hub.

A bearing cap shall be provided to hold the bottom motor bearing in a fixed position. Bearing housings shall be provided with fittings for lubrication as well as purging old lubricant.

The motor shall be fitted with heavy lifting eyes or lugs, each capable of supporting the entire weight of the pump and motor.

The pump motors shall be Premium Efficiency type, per NEMA MG-1 table 12-12, Inverter Ready per NEMA Part 31.4.4.2, with cast-iron frames, and be UL Recognized and CSA Approved. The motor windings shall be 200 C Inverter Spike-Resistant magnet wire and the rotors shall have an epoxy coating for corrosion protection.

CONTROLS

The control equipment shall be mounted in a NEMA Type 1 steel enclosure with 2 hinged access doors.

A grounding-type convenience outlet shall be provided on the side of the cabinet for operation of 120-volt AC devices.

Thermal magnetic air circuit breakers shall be provided for branch disconnect service and short circuit protection of all motor

control and auxiliary circuits.

Magnetic across-the-line starters with under-voltage release and overload coils for each phase shall be provided for each pump motor to give positive protection. Each single-phase auxiliary motor shall be equipped with an over-current protection device in addition to the branch circuit breaker, or shall beimpedance protected.

All wiring shall be labeled with thermal transfer self-laminating labels and a coded wiring diagram shall be provided.

FLOAT SWITCH LEVEL CONTROLS

To control the operation of the pumps with variations of liquid level in the wet well, a minimum of three (3) displacement switches shall be provided. A 30' (9 m) cord shall be provided with each switch. The cord shall have a corrosion-resistant vinyl jacket and be multi-stranded in order to prevent fatigue.

The displacement switch cords shall enter the wet well through cord grip seals mounted to a removable, gasketed floor plate. The floor plate shall allow the displacement switches to be adjusted or removed and replaced without having to enter or reach into the wet well.

An automatic alternator with manual switch shall be provided to change the sequence of operation of the pumps every eight hours. Alternating the pumps at less than eight-hour intervals will not be acceptable.

Provisions shall also be made for the pumps to operate in parallel should the level in the wet well continue to rise above the starting level for the low level pump.

HIGH WET WELL LEVEL ALARM

An adjustable displacement switch shall be provided to sense a high water level condition. The switch shall hang into the wet well and shall activate a contact to indicate the high water condition.

RUNNING TIME METER

A running time meter shall be supplied for each pump to show the number of hours of operation. The meter shall be enclosed in a dust and moisture-proof molded plastic case. The flush-mounted dial shall register in hours and tenths of hours up to 99,999.9 hours before repeating. The meter shall be suitable for operation from a 115-volt, 60 (50)-cycle supply.

PUMP FAILURE TO PRIME OR FAILURE TO PUMP ALARM (CHECK VALVE SWITCH TYPE)

To sense failure to deliver normal flow for any reason, including failure to prime, each pump shall be provided with a sealed sensor switch mounted in a protective ABS enclosure. The enclosure shall be mounted with an adjustable universal mounting bracket to the external arm of each discharge check valve. The mounting bracket shall allow the adjustment of the sensor switch with a single locking pivot adjustment. A red LED indicating light shall be provided on each switch unit to facilitate accurate setting of the switch for proper operation. The sensor switch shall monitor the movement of the check valve arm and thereby detect failure of the pump to deliver normal operating flow when called on to run. An auxiliary time delay relay shall be provided to prevent an alarm signal during the pump priming and startup period.

VACUUM-PRIMING SYSTEM

A vacuum priming system shall be furnished to prime the main pumps. The system shall be as shown on the vacuum priming schematic and shall include two vacuum pumps, providing 100 percent standby. Vacuum pumps shall have corrosion-resistant internal components. The vacuum priming system shall be complete with large port vacuum control solenoid valves, **SONIC START®** prime level sensor, float-operated check valves to protect the vacuum pumps, and all necessary shut-off valves as shown on the piping schematic. The float-operated check valves shall have a transparent body for visual inspection. All hoses and tubing used in the priming system shall be at least 3/8" (9.5 mm) nominal diameter.

The solenoid valves used in the vacuum priming system shall be of the high flow, direct acting brass body type, with threaded ports, NBR seals and 300 Series stainless steel plunger, rod, plate and springs.

The minimum orifice diameter shall be 5/16" (8 mm). The solenoid valves shall be UL Listed, with Class F coil rating and of suitable voltage and thermal capacity for the application.
Liquid level in the pump priming chamber shall be monitored by a **SONIC START®** resonant frequency liquid level probe.

The probe shall be equipped with a piezoelectric drive and sensitive circuits to detect frequency shifts when the probe is covered by liquid. The probe shall be completely sealed and have a 316L stainless steel housing for corrosion resistance. It shall be provided with a wiring connector molded of PolyPhenylSulfone, an amorphous high performance thermoplastic for impact and chemical resistance. The probe shall have a plug-in connector to facilitate easy removal.

The **SONIC START®** probe shall be provided with light emitting diodes. This diagnostic tool shall indicate connectivity, prime status or a fault condition. Systems utilizing an electrode, mechanical means such as a float, or that require any type of electrical or moving parts inside the priming chamber, which may accumulate debris, short out, bind or fail will not be acceptable.

The priming system shall automatically provide positive lubrication of the mechanical seal each time a main pump is primed. To prevent excessive stoppage due to grease accumulation, no passageway in the priming system through which the pumped liquid must pass shall be smaller than the equivalent of a 2-1/2" (64 mm) opening.

The vacuum priming system shall have two field selectable modes of operation. In the "On-Demand" mode, the priming system will operate only after a pump is called on to run, and if it is not primed. Once primed, the pump will be allowed to run. In the "Constant Prime" mode, both pumps are kept primed continuously, and ready to start immediately when called for.

ENVIRONMENTAL EQUIPMENT

A ventilating blower capable of delivering 250 CFM at 0.1" (118 l/s at 2.5 mm) static water pressure shall be provided in order to remove the heat generated by continuous motor operation. The ventilating blower shall be turned on and off automatically by a preset thermostat. A heavy extruded aluminum louvered grille with adjustable openings shall cover the discharge of the blower. A similar grille shall be provided in the other end of the station enclosure for air intake. A 500-watt electric heater controlled by a preset thermostat shall be furnished. The heater shall be rigidly mounted in the station to prevent removal.

SINGLE-PHASE 120-VOLT POWER TRANSFORMER PACKAGE

Suction Pipe Size	Aux. Heater	Min. Transformer Size
~~4"~~	~~No~~	~~3 KVA 208v~~
4"	No	2 KVA 230/460v
~~4"~~	~~Yes~~	~~3 KVA 208/230/460v~~
~~6" or 8"~~	~~No~~	~~*5 KVA 208/230/460v~~
~~6" or 8"~~	~~Yes~~	~~*5 KVA 208/230/460v~~

***[5 KVA NOT AVAILABLE WITH 4*2* PUMPS WITH 4" PIPING. USE 3 KVA]**

A (2) (3) (5) KVA insulating-type transformer shall be provided to supply power for lights, controls and auxiliary devices. The transformer shall have 240/480 volt primary, 120/240 volt secondary, Class F insulation, with temperature rise not to exceed 115°C above 40°C ambient. The core and coil assembly shall be given a double dip and bake. The coil shall be protected by a metal housing to prevent damage. The transformer shall be protected by a separate circuit breaker on the supply side.

.

MAIN PIPING

The pump suction connections shall be drilled and tapped for a 125-pound American Standard flange for easy attachment of the suction risers. The discharge line from each pump shall be fitted with a clapper-type check valve and eccentric plug valve. Size, location and quantity of check valves and plug valves shall be as shown on the construction drawing.

The check valve shall be of the spring-loaded type with external lever arm and an easily replaced resilient seat for added assurance against vacuum leaks. Check valves shall have stainless steel shaft with replaceable bronze shaft bushings. Ball-type check valves are specifically unacceptable for this application. An operating wrench shall be provided for the plug valves. All station piping and fittings shall be capable of passing a 3" (76 mm) spherical solid.

RAPID-JACK™ CHECK VALVE

The cast iron check valve body shall be designed so that the upper portion may be easily removed, without disturbing the end flange seals to adjacent piping, to service the shaft, arm and clapper or to remove any material which may be causing clogging. Provide one spare body gasket for each valve.

Protrusions through the station floor shall be sealed where necessary to effect sealing between the equipment chamber and the wet well. The suction and discharge connections, where they pass through the floor, shall be sealed by gaskets in order to prevent corrosive, noxious fumes from entering the station. Welded joints that do not allow adjustment or replacement will not be considered for this application. The pump station manufacturer shall extend the suction and discharge connections below the floor at the factory so that field connections can be made without disturbing the gas-tight seals.
Once the station is installed, however, it shall be possible to remove the entire 4" or 6" (100 or 150 mm) suction pipes through the station floor without having to enter the wet well to unbolt them.

The manufacturer of the pump station shall provide a compression-type sleeve coupling for installation on the common discharge pipe. A minimum of two anchoring points shall be provided on the bottom of the station baseplate for attachment of coupling joint restraints, which shall be provided by the installing contractor.

PROTECTED LIQUID FILLED COMPOUND PRESSURE GAUGES

A four-inch (4") (100 mm)Bourdon tube-type compound vacuum/pressure gauge with 3-1/2" (89 mm) dial, fitted with a brass stop valve and a manual air relief valve shall be provided for each pump. The gauges shall be mounted apart from the pumps, on a bracket attached to the control panel support structure, and connected to the pump discharge taps by flexible tubing to minimize vibration. The range of each gauge shall be selected to place the normal operating discharge pressure reading in the middle one-third of the scale and the gauge shall also be capable of measuring up to 30" HG (1.0 bar) of vacuum. The dial shall be white with black markings and the gauge itself shall have an accuracy of 1% of scale. The gauge shall be American made, with a Zytel Nylon case with 1/2" (13 mm) blow-out plug, stainless steel bezel, acrylic lens and phosphorus bronze tube with brass socket. Temperature compensation shall be provided by an internal compensating diaphragm. Gauges shall be protected from the service fluid by a Buna-N elastomer "boot" diaphragm within the stem, and the Bourdon tube and the space between the Bourdon tube and the internal isolating diaphragm shall be filled with low temperature instrument oil, completely isolating the gauge components from the fluid being measured.

CHECKLIST

The pump and pump station specifications and the following checklist must be met in total. There are many reasons for incorporating a good pump specification. For example, the stainless steel shaft with tapered impeller attachment is provided to minimize corrosion, extend seal life, and provide ease of impeller removal and seal replacement without use of a wheel puller. All items specified are for long life, durability and maintainability of the pumping equipment. Deviations from the pump specification will not be allowed.

The checklist is also provided to insure that the proper pumping system is provided to the owner.

FACTORY TESTS

All components of the pump station shall be given an operational test at the pump station manufacturer's facility to check for excessive vibration or leaks in the piping or seals, and to correct operation of the automatic control and vacuum priming systems and all auxiliary equipment. Installed pumps shall take suction from a deep wet well, simulating actual service conditions. The control panel shall undergo both a dry logic test and a full operational test with all systems operating.
Factory test instrumentation must include flow measuring with indicator; compound suction gauge; Bourdon tube-type discharge pressure gauge; electrical meters to measure amperes, volts, kilowatts and power factor; speed indicator; and a Vibrometer capable of measuring both amplitude and frequency.

SPARE PARTS

A complete replacement pump shaft seal assembly shall be furnished with each pump station. The spare seal shall be packed in a suitable container and shall include complete installation instructions. A spare volute gasket and seal gasket shall be provided.

An instructional video presentation on the pump mechanical seal system in DVD format shall be included. The DVD shall contain a presentation on the following subjects: purpose and location of the mechanical seal, signs of a defective mechanical seal, how to remove the mechanical seal, troubleshooting seal failure causes, seal components, required tools, how to reinstall the seal and how to place the pump back into service. The video shall include footage of an actual seal replacement.

INSTALLATION AND OPERATING INSTRUCTIONS

Installation of the pump chamber shall be done in accordance with the written instructions provided by the manufacturer.

Operation and maintenance manuals shall be furnished which will include parts lists of components and complete service

procedures and troubleshooting guide.

STARTUP

The Manufacturer shall provide the services of a factory-trained representative for a maximum period of one day on-site to perform initial startup of the pump station and to instruct the owners operating personnel in the operation and maintenance of the equipment.

WARRANTY

The manufacturer of the station shall warrant for one (1) year from date of start-up, not to exceed eighteen (18) months from date of shipment, that the structure and all equipment he provides will be free from defects in material and workmanship. Warranties and guarantees of the suppliers of various components in lieu of a single source responsibility by the Manufacturer will not be accepted. The Manufacturer shall assume prime responsibility for the warranty of the station and all components.

In the event a component fails to perform as specified or is proven defective in service during the warranty period, the Manufacturer shall repair or replace, at his discretion, such defective part.

He shall further provide, without cost, such labor as may be required to replace, repair or modify major components such as the steel structure, and main piping manifold. After start-up service has been performed, the labor to replace accessory items, such as the blower, priming pumps, alternator, etc., shall be the responsibility of others.

It is not intended that the Manufacturer assume responsibility for contingent liabilities or consequential damages of any nature resulting from defects in design, material, workmanship or delays in delivery, replacement or otherwise.

The motor adapter, volute, impeller, fiberglass enclosure and steel base shall be covered by a 10-year pro-rated warranty. The fiberglass enclosure shall be warranted against failure of the fiberglass components. The steel base shall be warranted against structural failure and perforation due to corrosion.

The pro-rated warranties shall be computed on a monthly basis starting at shipment, and shall cover replacement parts only.

The repair or replacement of those items normally consumed in service, such as grease, light bulbs, etc., shall be considered as part of routine maintenance and upkeep.

The manufacturer shall provide a warranty certificate covering specific details.

MANUFACTURER'S INSURANCE

ALL EQUIPMENT MANUFACTURERS, either direct or subcontractors to the general or mechanical contractors, SHALL HAVE in effect at TIME OF BID, CONTRACT AWARD, CONTRACT PERFORMANCE, and WARRANTY TERM, PRODUCT AND COMPREHENSIVE LIABILITY INSURANCE, INCLUDING SUDDEN AND ACCIDENTAL POLLUTION COVERAGE in the amount of FIVE MILLION DOLLARS, $5,000,000, through an insurance company with a minimum rating of A+ (SUPERIOR) XV according to the BEST'S INSURANCE REPORTS. All policies must be written on an OCCURRENCE BASIS. Policies written on a CLAIMS MADE BASIS are not acceptable. A typical CERTIFICATE OF INSURANCE attesting to the specified coverage issued by the responsible carrier naming the ENGINEER OF RECORD and the OWNER as ADDITIONAL INSURED must be presented to the named additional insured prior to contract award. A FAILURE TO COMPLY with this requirement BY THE BIDDER will require DISQUALIFICATION of the BID and CONTRACT AWARD.

MANUFACTURED EQUIPMENT
OPTION 1 (STANDARDIZATION)

The specifications and drawings detail Smith & Loveless equipment and represent the minimum standard of quality for both equipment and materials of construction. The contractor shall prepare his bid on the basis of the particular equipment and materials specified for the purpose of determining the low bid.

The owner has standardized on the named equipment in order to optimize their operation, facilitate maintenance and safety programs, provide for interchangeability of costly equipment items, reduce stocking levels required for necessary spare parts

and provide increased flexibility in the utilization of their pumping equipment. Equipment substitutions, since incompatible with the district's standardization program, will not be considered.

BID SUBMITTAL

This submittal shall include all necessary information for the proper determination of the acceptability of the proposed substitution and shall not necessarily be limited to the following.

A. Complete description of the equipment, system, process, or function, including a list of system components and features, drawings, catalog information and cuts, manufacturer's specifications, including materials description.
B. Performance data and curves, and horsepower requirements.
C. Outside utility requirements, such as water power, air, etc.
D. Functional description of any internal instrumentation and control supplied including list of parameters monitored, controlled, or alarmed.
E. Addresses and phone numbers of nearest service centers and a listing of the manufacturer's or manufacturer's representatives' services available at these locations, including addresses and phone numbers of the nearest parts warehouses capable of providing full parts replacement and/or repair services.
F. A list of five installations in the states where similar equipment by the manufacturer is currently in similar service; include contact name, telephone number, mailing address of the municipality or installation, engineer, owner, and installation contractor; if five installations do not exist, the list shall include all that do exist, if any.
G. Detailed information on site, architectural, structural, mechanical, plumbing, electrical, and control, and all other changes or modifications to the design and construction work necessary to adapt the equipment or systems to the arrangement shown and/or functions described on the drawings and in the technical specifications. This shall include plan view and section sketches illustrating any additional space requirements necessary to provide the minimum adequate clear space within and around the equipment for operation and maintenance, as shown on the drawings and specified.
H. All differences between the specifications and the proposed substitute equipment shall be clearly stated in writing under a heading of "differences".
I. Other specified submittal requirements listed in the detailed equipment and material specifications.
J. A completed and signed copy of the “Pump Station Certification Affidavit” which follows.

EVALUATION

Approval of the substitution to bid as an alternate shall in no way relieve the contractor from submitting the specified shop drawings for approval or complying fully with all provisions of the specifications and drawings.

If substituted equipment is accepted, the contractor shall, at his own expense, make any changes in the structures, piping, electrical, etc. necessary to accommodate the equipment. If engineering is required due to substitution of alternate equipment, the contractor shall pay for all engineering charges.

To receive final consideration, copies of the manufacturers' quotations for the equipment may be required to document the savings to the satisfaction of the engineer. It is the intent that the owner shall receive the full benefit of the savings in cost of equipment and the contractor's bid price shall be reduced by an amount equal to the savings. In all technical and other evaluations, the decision of the engineer is final.

STATION MONITORING PACKAGE

Pump overload trip alarm from starter overload trip
Time delay to prevent simultaneous pump starts
Phase failure/reversal monitor with pump motor shutdown on fault
Control power failure alarm

COLD CLIMATE PACKAGE

For cold weather operation, the station shall be provided with a 1300/1500 watt, dual range auxiliary heater with automatic circulating fan, thermostat control and an On/Off switch. The auxiliary heater shall be plugged into the station’s duplex receptacle. In addition, the fiberglass cover shall have a minimum of 1” thick urethane insulation, protected by fiberglass, with an “R” value of 7 or more. Also, the priming system shall be interlocked with the station temperature sensor so that, should the station ambient temperature fall below a pre-set minimum, solenoid valves shall open the priming system to atmospheric pressure, when the pumps are not running, allowing the liquid in the pumps and piping to drain back into the wet well, preventing freezing.

ENHANCED ALARM PACKAGE

A timer circuit shall be provided in the control panel to signal unauthorized entry into the pump station. The timer shall be activated whenever the fiberglass cover is opened. A key operated switch shall be provided on the station control panel to provide authorized personnel a means to deactivate the alarm before the timer completes its cycle. In addition to the High Water Alarm, the level control system shall be capable of indicating a Low Water Alarm. The station control panel shall also be provided with a maintained contact, manually operated, red mushroom head Emergency Stop Button in an easily accessible position on the top of the control panel to shut down the main pumps and remove power from the control circuits. Actuation of the switch shall also signal an alarm condition. This switch may also function as an emergency operator assist alarm, and provide means for testing the alarm system.

SECTION 1 - ALARM SENSORS

LOW WET WELL LEVEL ALARM

An adjustable displacement switch shall be provided to sense a low water level condition. The switch shall hang into the wet well and shall activate a contact to indicate the low water condition.

PHASE MONITOR

A relay with double pole, double throw contacts shall be provided to monitor and protect against phase loss (single-phasing), under voltage (brownouts) and phase reversal (improper sequence). It shall automatically reset when three-phase service returns to normal.

MOTOR CURRENT MONITORS

Motor current readings shall be displayed on separate panel mounted analog meters for each pump. Current transformers and associated circuitry shall be provided in the panel.

SINGLE-PHASE POWER MONITOR

A relay shall be provided to monitor the 120-Volt single-phase control power supply and initiate an alarm on loss of power. It shall automatically reset when the single-phase service returns to normal.

DEDICATED PUMP PRIME FAILURE

A time delay relay shall be connected to each vacuum pump. Contacts shall be provided to automatically shut down the operating vacuum pump, allow starting of the next pump in the operating sequence and signal an alarm on excessive vacuum pump operating time. Contacts shall be provided for transmitting an alarm signal.

OPERATOR ASSIST ALARM

The station control panel shall be provided with a maintained contact, manually operated, red mushroom-head Operator Assist Alarm Button in an easily accessible position on the control panel to signal emergency operator assistance is required. It also may be used to provide means for testing the alarm system.

UNAUTHORIZED ENTRY ALARM

A timer circuit shall be provided in the control panel to signal unauthorized entry into the pump station. The timer shall be activated whenever the fiberglass cover is opened. A key operated switch shall be provided on the station control panel to provide authorized personnel a means to deactivate the alarm before the timer completes its cycle.

SECTION 2 - ALARM INDICATORS

120V ALARM LIGHT

A vapor-proof light fixture with 50-watt lamp for outdoor pole mounting shall be provided with a red globe and guard.

120V ALARM LIGHT WITH FLASHER

A vapor-proof light fixture with 50-watt flashing lamp for outdoor pole mounting shall be provided. The light shall flash during alarm conditions. The fixture shall be complete with a red globe and guard.

120V ALARM BELL
A vibratone-type bell mounted on a weather-tight box suitable for pole mounting shall be provided.

120V ALARM HORN
A vibratone-type horn mounted on a weather-tight box suitable for pole mounting shall be provided.

12V TRICKLE CHARGER
Storage batteries and charger shall be supplied to furnish power for operating alarm annunciators in cases of power failure. The storage batteries (Two 3-cell, 6-volt) shall be maintenance-free lead-calcium battery concealed in high impact, heat-resistant and permanently sealed containers. The battery charger shall be solid-state, capable of restoring battery to full charge within 12 hours after a discharge, not exceeding 1.5 hours. Brownout protection is standard, and will activate the unit when AC line voltage drops below 85 volts.

12V ALARM LIGHT
A vapor-proof light fixture with 50-watt lamp for outdoor pole mounting shall be provided with a red globe and guard.

12V ALARM LIGHT WITH FLASHER
A vapor-proof light fixture with 50-watt lamp for outdoor pole mounting shall be provided with a red globe and guard. The light shall flash during alarm conditions.

12V ALARM BELL
A vibratone-type bell mounted on a weather-tight box suitable for pole mounting shall be provided.

12V ALARM HORN
A vibratone-type horn mounted on a weather-tight box suitable for pole mounting shall be provided.

REMOTE MOUNTED AUTOMATIC RESET ALARM SILENCE SWITCH
A momentary contact alarm-silencing switch mounted in a weatherproof box suitable for pole mounting shall be provided. The alarm shall automatically be reset when the alarm condition is removed.

PANEL MOUNTED AUTOMATIC RESET ALARM SILENCE SWITCH
A momentary contact alarm silencing switch mounted on the control panel shall be provided. The alarm shall automatically be reset when the alarm condition is removed.

PANEL MOUNTED MANUAL RESET ALARM SILENCE SWITCH
A manual alarm silencing switch mounted on the control panel shall be provided. The switch shall be manually reset when the alarm condition is removed.

REMOTE ALARM CONTACTS
In addition to the common, powered local alarm connection, individual unpowered contacts shall be provided and wired to a terminal strip for field connection to a remote alarm monitoring system (not included).

TEST UNIT WITH BATTERY FOR MULTI-SENSOR CHECK VALVE SWITCH [FOR USE WITH RELAY LOGIC CONTROLS.]
To test or set the multi-sensor check valve switches using the built-in LED light with Relay Logic control systems, a separate hand held battery pack with connecting cord and plug shall be provided. This is to enable the operator to accurately set the trip point of the switch manually, by means of the built-in test light on the multi-sensor.

DISCRETE CONTACTS FOR ALARM DIALER INTERFACE (DIALER NOT INCLUDED)
Provisions shall be made within the pump station to facilitate the field installation of an alarm dialer, which is to be furnished and installed by others. The alarm dialer shall be as described elsewhere in these specifications.
The factory built pump station shall be provided with a mounting bracket approximately 12 inches by 10-5/8 inches to attach

and support the alarm dialer, near the station control panel, beneath the fiberglass enclosure. In addition, openings for conduit connections shall be provided in the bottom of the station control panel and through the side of the station base, to facilitate wiring of the alarm dialer input, output and power connections. In addition to the powered common local alarm contact, the station control panel shall have terminal strip connections for fault-opening alarm contacts to provide up to 8 discrete alarm input signals (depending on the packages and options selected) to the dialer and shall also include terminal strip connections for a 1/60/120 volt power source, on a separate 15-amp circuit, to power the dialer. Wiring of the dialer shall be done by others during installation of the station in the field.

SECTION 3 - WET WELL ACCESSORIES

WET WELL FALL PROTECTION BARRIER

A fall protection safety barrier to prevent personnel, tools or equipment from falling through the manway opening and into the wet well when the manway cover is in the raised position, shall be provided by the station manufacturer for field installation in the wet well by the installing contractor. The fall protection barrier shall be constructed of aluminum bar grating and shall cover the area beneath the manway cover. Stainless steel hinges and a lifting handle shall be provided for convenience. When fully open, the fall protection safety barrier can be latched open for safe entering and exiting of the wet well. All components shall be constructed of stainless steel except for the aluminum grating. The barrier shall be capable of holding a 400-pound concentrated load, when in the Closed position.

The wet well fall protection barrier kit shall include the aluminum grating barrier, 304 SST hinges, 304 SST mounting brackets, 304 SST hardware, the required number of 1/2" diameter 304 SST wedge anchors for the specific wet well kit size and a complete set of instructions for installation of the fall protection barrier in a foot diameter wet well.

SECTION 4 - MECHANICAL

ADDITIONAL SPARE MECHANICAL SEALS

In addition to the one standard spare mechanical seal, additional spare mechanical seal(s) shall be provided. The spare seal(s) shall be packed in a suitable container and shall include complete installation instructions.

REMOVE FIBERGLASS ENCLOSURE

The fiberglass enclosure, station ventilating blower, and 500-watt electric heater shall not be provided.

REMOVE MANWAY ACCESS COVER

The aluminum treadplate manway access cover, stainless steel piano hinge and hardware shall not be provided.

EMERGENCY PUMPING CONNECTION

The common discharge pipe of the pump station shall be fitted with a branch with a [3"(75 mm), 4" (100 mm)] plug valve and male quick-connect fitting, with cap, as shown on the drawings, to facilitate connection of a portable emergency pump to the force main, to bypass the pump station. The emergency pumping connection shall be housed within the station's fiberglass cover.

SECTION 5 - CONTROL PANEL

MAIN CIRCUIT BREAKER

A main circuit breaker shall be installed in the control panel to provide over-current protection for the station, and shall be capable of being used to disconnect the three-phase power to the pump station.

The breaker shall be operable without opening the panel, and shall be interlocked with the panel door. It shall be capable of being padlocked in the "Off" position.

MAIN DISCONNECT SWITCH

A main disconnect switch shall be provided to disconnect the three-phase power to the pump station. The switch shall be operable without opening the panel, and shall be interlocked with the panel door. It shall be capable of being padlocked in the "Off" position.

TIME DELAY
The control system shall provide for a time delay to prevent simultaneously starting the pump motors after power failure.

GENERATOR INTERLOCK
Provisions shall be made in the control circuit of the lift station to facilitate locking out the standby pump when the emergency generator set is powering the station. An interlock consisting of a normally closed auxiliary contact shall be supplied with the emergency generator controls by the generator manufacturer. This normally closed contact shall be wired to the terminal blocks provided in the lift station control panel by the lift station manufacturer. The interconnecting wiring shall be supplied and connected by the installing contractor.

INTRINSICALLY SAFE CONTROL
Intrinsically safe relays to provide low current isolated switching for the float switches shall be provided.

NON-MERCURY FLOAT SWITCHES
The level control float switches shall be of the mercury free design, operated by a rolling steel ball traveling back and forth within a switch tube, to actuate a snap action switch, all mounted in a sealed plastic float housing, supported by a watertight cord. An integral weight shall cause inversion on submergence.

SOLID-STATE STARTERS
UL listed, solid-state reduced voltage starters shall be supplied. The starters shall be capable of a soft start and soft stop. The starters shall have built in overload protection as well as built in bypass contactors. One set of Form C auxiliary contacts shall be supplied on the starter. The starters shall have a built-in Digital Signal Processor utilizing a low impedance run circuit. The starters shall be easily programmable by using a standard screwdriver.

NEMA STARTERS
NEMA rated magnetic across-the-line starters with overload protection for each phase shall be provided for each pump motor to give positive protection against phase unbalance, thermal overload, phase loss and ground fault.

STAINLESS STEEL PANEL
The control equipment shall be mounted in a NEMA-type 4X stainless steel enclosure with two-section, piano hinged, lockable doors.

RUNNING TIME METER FOR PARALLEL OPERATION
A third running time meter shall be supplied to show the number of hours of operation with both pumps running in parallel. The meter shall be enclosed in a dust and moisture-proof molded plastic case. The flush mounted dial shall register in hours and tenths of hours up to 99,999.9 hours before repeating.
The meter shall be suitable for operation from a 115-volt, 60-cycle supply.

PUMP RUNNING LIGHTS
A green panel light to indicate “Pump On” shall be provided for each main pump.

BASE1-BASE2-AUTO ALTERNATE SELECTOR SWITCH
A 3-position selector switch shall be mounted on the face of the control panel to allow selection of either pump as the lead pump, or to allow for automatic alternation.

SURGE PROTECTIVE DEVICE
A surge protective device for lightning and surge protection with an internal automatic discharge circuit and rated for three-phase service shall be provided.

TIME DELAY
The pump control system shall provide for a time delay to prevent simultaneously starting the pump motors after power failure.

SEQUENTIAL ALTERNATION
In lieu of the timed alternation system, provisions shall be made to alternate the pumps at the completion of each pumping cycle.

EXTRA 20 AMPERE CIRCUIT BREAKER(S)
The main control panel shall contain spare 20 amp, single pole 120v circuit breaker(s) to power external equipment supplied by others.

ADD-A-PHASE INTERFACE
Terminals shall be provided in the lift station control panel to facilitate connection to an external Add-A-Phase phase converter unit.

ROTO PHASE INTERFACE
Terminals and a time delay to prevent simultaneously starting the pump motors after power failure shall be provided in the lift station control panel to facilitate connection to an external Roto Phase phase converter unit.

SECTION 6 - ENVIRONMENTAL

AUXILIARY STATION HEATER
A 1300/1500 watt, dual range, electric heater with automatic circulating fan, thermostat control and an On/Off switch is to be provided. The heater is to be operated by connection to the station convenience receptacle.

INSULATED HOOD
The fiberglass cover shall have a minimum of 1" thick urethane insulation, protected by fiberglass, with an "R" value of 7 or more.

SECTION 7 – MISCELLANEOUS

TOOLKIT
A metal toolbox complete with the following tools shall be provided. This complement of tools shall include all tools necessary to replace the pump mechanical seal.

9/16" x 1/2" Box End Wrench
3/4" x 5/8" Open End Wrench
15/16" x 1" Open End Wrench
1-1/8" Socket
8" T-Handle 11" x 1/2" Drive
1/2" x 5-1/2" Drive Extension
6" Pipe Wrench
#3 Rawhide Mallet
Ratchet-Type Hoist
Motor Lifting Bar
Lint-Free Cloth
Multi-Purpose Grease

4329 WILDWOOD ROAD

CITY OF MEMPHIS

SARP10 PROGRAM

DECEMBER 1, 2021
CONSTRUCTION DOCUMENTS

PREPARED BY: PICKERING FIRM, INC.

FOR REFERENCE – SEE PLANS FOR PROJECT REQUIREMENTS

SECTION 11310 – WET WELL MOUNTED PUMP STATION WITH DUPLEX NON-CLOG PUMPS

GENERAL

The contractor shall furnish and install one factory-built, automatic pumping station as manufactured by Smith & Loveless, Inc., or approved equal. The station shall be complete with all needed equipment, factory-installed on a welded steel base with a hinged fiberglass cover.

The principal items of equipment shall include two vertical, close-coupled, motor driven, vacuum primed, non-clog pumps; valves; internal piping; central control panel with circuit breakers; motor starters and automatic pumping level controls; heater; ventilating blower; priming pumps with **SONIC START®** pump prime detection system and appurtenances; and all internal wiring.

OPERATING CONDITIONS

Each pump shall be capable of delivering * GPM (l/s) of raw water or wastewater against a total dynamic head of * feet (m). The minimum acceptable pump efficiency at this condition shall be 51%. Due to the energy conservation requirements, the minimum efficiency will be enforced. The maximum allowable speed shall be * RPM. The minimum rated horsepower (kw) of each pump motor shall be *. The actual static suction lift, measured from the station baseplate to the "off" level in the wet well, shall be 21.0' (m) at *' (m) elevation above Mean Sea Level. The pumps shall be capable of meeting or exceeding this value, at the specified altitude.

The minimum specified pump efficiency is %. Should a Contractor wish to propose an alternate pump which does not meet or exceed the specified efficiency, the Contractor will be required to provide, 15 days prior to the bid opening, a pre-bid submittal packet with the proposed pump details, pump curve and efficiency. The submittal will be accompanied by a 25 year cost of operation difference calculation. The energy cost difference, due to reduced efficiency, over a 25 year period, calculated at $** per KWH, shall be applied as an adder when evaluating the alternate manufacturer's bid number.

All openings and passages shall be large enough to permit the passage of a sphere 3" (75 mm) in diameter and the pump shall have a flanged suction and discharge connection no smaller than 4" (100 mm). The anticipated operating head range is from * feet (m) minimum to * feet (m) maximum. The pump motors shall not be overloaded beyond their nameplate rating at the design conditions nor at any head in the operating range.

*- Refer to Design Drawings for Pump Data at each site.
**- Refer to standard power rates per Memphis Light Gas and Water Division

CONSTRUCTION

The station shall be constructed in one complete, factory-built assembly. It shall be sized to rest on the top of the wet well as detailed in the construction drawings.

A. EPOXY COATED CARBON STEEL BASEPLATE

The supporting floor plate shall be minimum [3/8" (9.5 mm), ½" (13 mm), 1" (25 mm)] thick carbon steel with reinforcing, as required, to prevent deflection and ensure an absolutely rigid support. Steel plate shall meet or exceed ASTM A-36 specifications.

WELDING

All steel structural members shall be joined by electric arc welding with welds of adequate section for the joint involved. Structural welding shall be preformed in accordance with AWS standards and procedures.

PROTECTION AGAINST CORROSION

All structural steel surfaces shall be factory blasted with steel grit, in an environmentally controlled booth, to remove rust, mill scale, weld slag, etc. All weld spatter and surface roughness shall be removed by grinding. Surface preparation shall comply with SSPC-SP6 specifications. Sandblasting is specifically prohibited.

Immediately following cleaning, a single 6-8 mil (0.15-0.20 mm) dry film thickness coating of VERSAPOX®, a self-priming

Cycloaliphatic Amine Epoxy shall be factory applied to the base. After curing, a 2-3 mil (0.05-0.08 mm) DFT top coating of XTRATHANE™, a moisture-cured Aliphatic Polyurethane protective finish, for abrasion resistance and weather protection, shall be applied to the top of the base. These coatings shall be as formulated by Smith & Loveless specifically for this type of application and service.

Stainless steel, aluminum and other corrosion-resistant surfaces shall not be coated. Carbon steel surfaces not otherwise protected shall be coated with a suitable non-hardening rust preventative compound. Auxiliary components such as the electrical enclosure, ventilating blower and vacuum pumps shall be furnished with the original manufacturer's coating.

Finish coating shall be accomplished prior to shipment of the station from the factory and shall comply fully with the intent of these specifications. A touch-up kit shall be provided by the pump station manufacturer for repair of any mars or scratches occurring during shipping and installation. This kit shall contain detailed instructions for use.

MAIN PUMPS

The pumps shall be 4" vertical, centrifugal non-clog type of heavy cast-iron construction, especially designed for the use of mechanical seals and vacuum priming. In order to minimize seal wear caused by linear movement of the shaft, the shaft bearing nearest the pump impeller shall be locked in place so that endplay is limited to the clearance within the bearing. To minimize seal wear resulting from shaft deflection caused by the radial thrust of the pump, the shaft from the top of the impeller to the lower bearing supporting the impeller shall have a minimum diameter of 1-7/8" (48 mm) for motor frame sizes 213 through 286; 2-1/8" (54 mm) for motor frame sizes 324 and 326; and 3" (76 mm) for frame 364 and larger. The dimension from the lowest bearing to the top of the impeller shall not exceed 6" (152 mm). The motor shaft shall be directly connected to the impeller without the use of drive belts or couplings, which require alignment and maintenance, and which increase power consumption due to their inherent energy losses.

Pumps with less than a standard 4" (100 mm) suction or 4" (100 mm) discharge connection, or with less than a 3" (76 mm) spherical solids handling capacity will be rejected for this application.

The oversized shaft incorporating oversized bearings and heavier bearing frame construction provides for extended mechanical seal, bearing and overall pump/motor life. Since the larger shaft with the specified minimum overhang is the key to heavier, more rigid construction throughout, no deviation from the specified shaft diameter or tolerances will be allowed.

The bearing nearest the impeller shall be designed for the combined thrust and radial load. The upper bearing shall be free to move in a linear direction with the thermal expansion of the shaft and shall carry only radial loads.

The shaft shall be solid stainless steel through the mechanical seal to eliminate corrosion and abrasive rust particles. Removable shaft sleeves will not be acceptable if the shaft under the sleeve does not meet the specified minimum diameter.

The pump shall have an integral adapter providing a large water reservoir above the impeller to provide for positive exclusion of air from the impeller. The seal shall be inside this area to assure lubrication. Pumps which do not use hollow priming adapters for positive lubrication of the seal will not be acceptable. Self-priming pumps are specifically unacceptable due to the need for suction check valves, air vent piping and the possibility of overheating and damaging the pump or producing steam or high temperatures in the pump, which may be a hazard to the operator, when the pump is run dry.

The pump controls must be set so that the main pumps cannot be turned on unless they are filled with liquid, and the pump is completely primed.

The pump shall be constructed so as to permit priming from the lower pressure area behind the impeller. Priming from high-pressure connections, which tends to cause solids to enter and clog the priming system, will not be acceptable. The priming bowl shall be transparent, enabling the operator to monitor the priming level.

The pump shall be arranged so that the rotating element can easily be removed from the casing without disconnecting the electrical wiring or disassembling the motor, impeller, backhead or seal, so that any foreign object may be removed from the pump or suction line. Enclosed impellers must be used to avoid the necessity of wear plates and the associated costs of replacement and maintenance of wear plate clearances with semi-open impellers.

The pump shaft shall be sealed against leakage by a single mechanical seal constructed so as to be automatically drained and primed each time the pump is drained and primed. Water, which lubricates the mechanical seal, shall be automatically drained

from around the seal if the pump loses prime in order to allow both the pump and the seal to be drained, thereby preventing freezing and breakage of the seal during power outages in sub-freezing temperatures.

The seal shall be of carbon and ceramic materials with the mating surfaces lapped to a flatness tolerance of one light band. The rotating ceramic shall be held in mating position with the stationary carbon by a stainless steel spring. The entire seal assembly shall be held in place by a bronze seal housing to prevent excessive heat buildup. Use of cast-iron or other ferrous material for the seal housing which will rust and damage the seal, shortening its life, will not be acceptable.

The pump volute shall be furnished with mounting lugs and bolted to the station floor plate, forming a gas-tight seal.

A. NON-CLOG TWO-PORT IMPELLER (4" & 6" PUMP OPTION) [(100 & 150 MM PUMP OPTION)]

The pump impeller shall be of the enclosed two-port type made of close-grained cast-iron and shall be balanced. The eye of the impeller as well as the ports shall be large enough to permit the passage of a sphere 3" (76 mm) in diameter in accordance with nationally recognized codes. The impeller shall be keyed with a stainless steel key and secured to the motor shaft by a stainless steel capscrew equipped with a Nylock or other suitable self-locking device. The impeller shall not be screwed or pinned to the motor pump shaft and shall be readily removable without the use of special tools. To prevent the buildup of stringy materials, grit and other foreign particles around the pump shaft, all impellers less than full diameter shall be trimmed inside the impeller shrouds. The shrouds shall remain full diameter so that close minimum clearance from shrouds to volute is maintained. Both the end of the shaft and the bore of the impeller shall be tapered to permit easy removal of the impeller from the shaft.

MOTORS

The pump motors shall be vertical, solid shaft, NEMA P-base, squirrel-cage induction type, suitable for 3 phase, 60 cycle, 230 volt electric current.

They shall have Class F insulation. Insulation temperature shall, however, be limited to Class B. The motors shall have normal starting torque and low-starting current, as specified by NEMA Design B characteristics. They shall be open drip-proof design with forced air circulation by integral fan. Openings for ventilation shall be uniformly spaced around the motor frame. Leads shall be terminated in a cast connection box and shall be clearly identified.

The motors shall have 1.15 service factor. The service factor shall be reserved for the owner's protection. The motors shall not be overloaded beyond their nameplate rating, at the design conditions, nor at any head in the operating range as specified under Operating Conditions.

The motor-pump shaft shall be centered, in relation to the motor base, within .005" (0.127 mm). The shaft runout shall not exceed .003" (0.076 mm).

The motor shaft shall equal or exceed the diameter specified under Main Pumps at all points from immediately below the top bearing to the top of the impeller hub.

A bearing cap shall be provided to hold the bottom motor bearing in a fixed position. Bearing housings shall be provided with fittings for lubrication as well as purging old lubricant.

The motor shall be fitted with heavy lifting eyes or lugs, each capable of supporting the entire weight of the pump and motor.

The pump motors shall be Premium Efficiency type, per NEMA MG-1 table 12-12, Inverter Ready per NEMA Part 31.4.4.2, with cast-iron frames, and be UL Recognized and CSA Approved. The motor windings shall be 200 C Inverter Spike-Resistant magnet wire and the rotors shall have an epoxy coating for corrosion protection.

CONTROLS

The control equipment shall be mounted in a NEMA Type 1 steel enclosure with 2 hinged access doors.

A grounding-type convenience outlet shall be provided on the side of the cabinet for operation of 120-volt AC devices.

Thermal magnetic air circuit breakers shall be provided for branch disconnect service and short circuit protection of all motor

control and auxiliary circuits.

Magnetic across-the-line starters with under-voltage release and overload coils for each phase shall be provided for each pump motor to give positive protection. Each single-phase auxiliary motor shall be equipped with an over-current protection device in addition to the branch circuit breaker, or shall be impedance protected.

All wiring shall be labeled with thermal transfer self-laminating labels and a coded wiring diagram shall be provided.

FLOAT SWITCH LEVEL CONTROLS

To control the operation of the pumps with variations of liquid level in the wet well, a minimum of three (3) displacement switches shall be provided. A 30' (9 m) cord shall be provided with each switch. The cord shall have a corrosion-resistant vinyl jacket and be multi-stranded in order to prevent fatigue.

The displacement switch cords shall enter the wet well through cord grip seals mounted to a removable, gasketed floor plate. The floor plate shall allow the displacement switches to be adjusted or removed and replaced without having to enter or reach into the wet well.

An automatic alternator with manual switch shall be provided to change the sequence of operation of the pumps every eight hours. Alternating the pumps at less than eight-hour intervals will not be acceptable.

Provisions shall also be made for the pumps to operate in parallel should the level in the wet well continue to rise above the starting level for the low level pump.

HIGH WET WELL LEVEL ALARM

An adjustable displacement switch shall be provided to sense a high water level condition. The switch shall hang into the wet well and shall activate a contact to indicate the high water condition.

RUNNING TIME METER

A running time meter shall be supplied for each pump to show the number of hours of operation. The meter shall be enclosed in a dust and moisture-proof molded plastic case. The flush-mounted dial shall register in hours and tenths of hours up to 99,999.9 hours before repeating. The meter shall be suitable for operation from a 115-volt, 60 (50)-cycle supply.

PUMP FAILURE TO PRIME OR FAILURE TO PUMP ALARM (CHECK VALVE SWITCH TYPE)

To sense failure to deliver normal flow for any reason, including failure to prime, each pump shall be provided with a sealed sensor switch mounted in a protective ABS enclosure. The enclosure shall be mounted with an adjustable universal mounting bracket to the external arm of each discharge check valve. The mounting bracket shall allow the adjustment of the sensor switch with a single locking pivot adjustment. A red LED indicating light shall be provided on each switch unit to facilitate accurate setting of the switch for proper operation. The sensor switch shall monitor the movement of the check valve arm and thereby detect failure of the pump to deliver normal operating flow when called on to run. An auxiliary time delay relay shall be provided to prevent an alarm signal during the pump priming and startup period.

VACUUM-PRIMING SYSTEM

A vacuum priming system shall be furnished to prime the main pumps. The system shall be as shown on the vacuum priming schematic and shall include two vacuum pumps, providing 100 percent standby. Vacuum pumps shall have corrosion-resistant internal components. The vacuum priming system shall be complete with large port vacuum control solenoid valves, **SONIC START®** prime level sensor, float-operated check valves to protect the vacuum pumps, and all necessary shut-off valves as shown on the piping schematic. The float-operated check valves shall have a transparent body for visual inspection. All hoses and tubing used in the priming system shall be at least 3/8" (9.5 mm) nominal diameter.

The solenoid valves used in the vacuum priming system shall be of the high flow, direct acting brass body type, with threaded ports, NBR seals and 300 Series stainless steel plunger, rod, plate and springs.

The minimum orifice diameter shall be 5/16" (8 mm). The solenoid valves shall be UL Listed, with Class F coil rating and of suitable voltage and thermal capacity for the application.
Liquid level in the pump priming chamber shall be monitored by a **SONIC START®** resonant frequency liquid level probe.

The probe shall be equipped with a piezoelectric drive and sensitive circuits to detect frequency shifts when the probe is covered by liquid. The probe shall be completely sealed and have a 316L stainless steel housing for corrosion resistance. It shall be provided with a wiring connector molded of PolyPhenylSulfone, an amorphous high performance thermoplastic for impact and chemical resistance. The probe shall have a plug-in connector to facilitate easy removal.

The **SONIC START®** probe shall be provided with light emitting diodes. This diagnostic tool shall indicate connectivity, prime status or a fault condition. Systems utilizing an electrode, mechanical means such as a float, or that require any type of electrical or moving parts inside the priming chamber, which may accumulate debris, short out, bind or fail will not be acceptable.

The priming system shall automatically provide positive lubrication of the mechanical seal each time a main pump is primed. To prevent excessive stoppage due to grease accumulation, no passageway in the priming system through which the pumped liquid must pass shall be smaller than the equivalent of a 2-1/2" (64 mm) opening.

The vacuum priming system shall have two field selectable modes of operation. In the "On-Demand" mode, the priming system will operate only after a pump is called on to run, and if it is not primed. Once primed, the pump will be allowed to run. In the "Constant Prime" mode, both pumps are kept primed continuously, and ready to start immediately when called for.

ENVIRONMENTAL EQUIPMENT

A ventilating blower capable of delivering 250 CFM at 0.1" (118 l/s at 2.5 mm) static water pressure shall be provided in order to remove the heat generated by continuous motor operation. The ventilating blower shall be turned on and off automatically by a preset thermostat. A heavy extruded aluminum louvered grille with adjustable openings shall cover the discharge of the blower. A similar grille shall be provided in the other end of the station enclosure for air intake. A 500-watt electric heater controlled by a preset thermostat shall be furnished. The heater shall be rigidly mounted in the station to prevent removal.

SINGLE-PHASE 120-VOLT POWER TRANSFORMER PACKAGE

Suction Pipe Size	Aux. Heater	Min. Transformer Size
4"	No	3 KVA 208v
4"	No	2 KVA 230/460v
4"	Yes	3 KVA 208/230/460v
6" or 8"	No	*5 KVA 208/230/460v
6" or 8"	Yes	*5 KVA 208/230/460v

***[5 KVA NOT AVAILABLE WITH 4*2* PUMPS WITH 4" PIPING. USE 3 KVA]**

A (2) (3) (5) KVA insulating-type transformer shall be provided to supply power for lights, controls and auxiliary devices. The transformer shall have 240/480 volt primary, 120/240 volt secondary, Class F insulation, with temperature rise not to exceed 115°C above 40°C ambient. The core and coil assembly shall be given a double dip and bake. The coil shall be protected by a metal housing to prevent damage. The transformer shall be protected by a separate circuit breaker on the supply side.

.

MAIN PIPING

The pump suction connections shall be drilled and tapped for a 125-pound American Standard flange for easy attachment of the suction risers. The discharge line from each pump shall be fitted with a clapper-type check valve and eccentric plug valve. Size, location and quantity of check valves and plug valves shall be as shown on the construction drawing.

The check valve shall be of the spring-loaded type with external lever arm and an easily replaced resilient seat for added assurance against vacuum leaks. Check valves shall have stainless steel shaft with replaceable bronze shaft bushings. Ball-type check valves are specifically unacceptable for this application. An operating wrench shall be provided for the plug valves. All station piping and fittings shall be capable of passing a 3" (76 mm) spherical solid.

RAPID-JACK™ CHECK VALVE

The cast iron check valve body shall be designed so that the upper portion may be easily removed, without disturbing the end flange seals to adjacent piping, to service the shaft, arm and clapper or to remove any material which may be causing clogging. Provide one spare body gasket for each valve.

Protrusions through the station floor shall be sealed where necessary to effect sealing between the equipment chamber and the wet well. The suction and discharge connections, where they pass through the floor, shall be sealed by gaskets in order to prevent corrosive, noxious fumes from entering the station. Welded joints that do not allow adjustment or replacement will not be considered for this application. The pump station manufacturer shall extend the suction and discharge connections below the floor at the factory so that field connections can be made without disturbing the gas-tight seals.
Once the station is installed, however, it shall be possible to remove the entire 4" or 6" (100 or 150 mm) suction pipes through the station floor without having to enter the wet well to unbolt them.

The manufacturer of the pump station shall provide a compression-type sleeve coupling for installation on the common discharge pipe. A minimum of two anchoring points shall be provided on the bottom of the station baseplate for attachment of coupling joint restraints, which shall be provided by the installing contractor.

PROTECTED LIQUID FILLED COMPOUND PRESSURE GAUGES

A four-inch (4") (100 mm)Bourdon tube-type compound vacuum/pressure gauge with 3-1/2" (89 mm) dial, fitted with a brass stop valve and a manual air relief valve shall be provided for each pump. The gauges shall be mounted apart from the pumps, on a bracket attached to the control panel support structure, and connected to the pump discharge taps by flexible tubing to minimize vibration. The range of each gauge shall be selected to place the normal operating discharge pressure reading in the middle one-third of the scale and the gauge shall also be capable of measuring up to 30" HG (1.0 bar) of vacuum. The dial shall be white with black markings and the gauge itself shall have an accuracy of 1% of scale. The gauge shall be American made, with a Zytel Nylon case with 1/2" (13 mm) blow-out plug, stainless steel bezel, acrylic lens and phosphorus bronze tube with brass socket. Temperature compensation shall be provided by an internal compensating diaphragm. Gauges shall be protected from the service fluid by a Buna-N elastomer "boot" diaphragm within the stem, and the Bourdon tube and the space between the Bourdon tube and the internal isolating diaphragm shall be filled with low temperature instrument oil, completely isolating the gauge components from the fluid being measured.

CHECKLIST

The pump and pump station specifications and the following checklist must be met in total. There are many reasons for incorporating a good pump specification. For example, the stainless steel shaft with tapered impeller attachment is provided to minimize corrosion, extend seal life, and provide ease of impeller removal and seal replacement without use of a wheel puller. All items specified are for long life, durability and maintainability of the pumping equipment. Deviations from the pump specification will not be allowed.

The checklist is also provided to insure that the proper pumping system is provided to the owner.

FACTORY TESTS

All components of the pump station shall be given an operational test at the pump station manufacturer's facility to check for excessive vibration or leaks in the piping or seals, and to correct operation of the automatic control and vacuum priming systems and all auxiliary equipment. Installed pumps shall take suction from a deep wet well, simulating actual service conditions. The control panel shall undergo both a dry logic test and a full operational test with all systems operating.
Factory test instrumentation must include flow measuring with indicator; compound suction gauge; Bourdon tube-type discharge pressure gauge; electrical meters to measure amperes, volts, kilowatts and power factor; speed indicator; and a Vibrometer capable of measuring both amplitude and frequency.

SPARE PARTS

A complete replacement pump shaft seal assembly shall be furnished with each pump station. The spare seal shall be packed in a suitable container and shall include complete installation instructions. A spare volute gasket and seal gasket shall be provided.

An instructional video presentation on the pump mechanical seal system in DVD format shall be included. The DVD shall contain a presentation on the following subjects: purpose and location of the mechanical seal, signs of a defective mechanical seal, how to remove the mechanical seal, troubleshooting seal failure causes, seal components, required tools, how to reinstall the seal and how to place the pump back into service. The video shall include footage of an actual seal replacement.

INSTALLATION AND OPERATING INSTRUCTIONS

Installation of the pump chamber shall be done in accordance with the written instructions provided by the manufacturer.

Operation and maintenance manuals shall be furnished which will include parts lists of components and complete service

procedures and troubleshooting guide.

STARTUP

The Manufacturer shall provide the services of a factory-trained representative for a maximum period of one day on-site to perform initial startup of the pump station and to instruct the owners operating personnel in the operation and maintenance of the equipment.

WARRANTY

The manufacturer of the station shall warrant for one (1) year from date of start-up, not to exceed eighteen (18) months from date of shipment, that the structure and all equipment he provides will be free from defects in material and workmanship. Warranties and guarantees of the suppliers of various components in lieu of a single source responsibility by the Manufacturer will not be accepted. The Manufacturer shall assume prime responsibility for the warranty of the station and all components.

In the event a component fails to perform as specified or is proven defective in service during the warranty period, the Manufacturer shall repair or replace, at his discretion, such defective part.

He shall further provide, without cost, such labor as may be required to replace, repair or modify major components such as the steel structure, and main piping manifold. After start-up service has been performed, the labor to replace accessory items, such as the blower, priming pumps, alternator, etc., shall be the responsibility of others.

It is not intended that the Manufacturer assume responsibility for contingent liabilities or consequential damages of any nature resulting from defects in design, material, workmanship or delays in delivery, replacement or otherwise.

The motor adapter, volute, impeller, fiberglass enclosure and steel base shall be covered by a 10-year pro-rated warranty. The fiberglass enclosure shall be warranted against failure of the fiberglass components. The steel base shall be warranted against structural failure and perforation due to corrosion.

The pro-rated warranties shall be computed on a monthly basis starting at shipment, and shall cover replacement parts only.

The repair or replacement of those items normally consumed in service, such as grease, light bulbs, etc., shall be considered as part of routine maintenance and upkeep.

The manufacturer shall provide a warranty certificate covering specific details.

MANUFACTURER'S INSURANCE

ALL EQUIPMENT MANUFACTURERS, either direct or subcontractors to the general or mechanical contractors, SHALL HAVE in effect at TIME OF BID, CONTRACT AWARD, CONTRACT PERFORMANCE, and WARRANTY TERM, PRODUCT AND COMPREHENSIVE LIABILITY INSURANCE, INCLUDING SUDDEN AND ACCIDENTAL POLLUTION COVERAGE in the amount of FIVE MILLION DOLLARS, $5,000,000, through an insurance company with a minimum rating of A+ (SUPERIOR) XV according to the BEST'S INSURANCE REPORTS. All policies must be written on an OCCURRENCE BASIS. Policies written on a CLAIMS MADE BASIS are not acceptable. A typical CERTIFICATE OF INSURANCE attesting to the specified coverage issued by the responsible carrier naming the ENGINEER OF RECORD and the OWNER as ADDITIONAL INSURED must be presented to the named additional insured prior to contract award. A FAILURE TO COMPLY with this requirement BY THE BIDDER will require DISQUALIFICATION of the BID and CONTRACT AWARD.

MANUFACTURED EQUIPMENT
OPTION 1 (STANDARDIZATION)

The specifications and drawings detail Smith & Loveless equipment and represent the minimum standard of quality for both equipment and materials of construction. The contractor shall prepare his bid on the basis of the particular equipment and materials specified for the purpose of determining the low bid.

The owner has standardized on the named equipment in order to optimize their operation, facilitate maintenance and safety programs, provide for interchangeability of costly equipment items, reduce stocking levels required for necessary spare parts

and provide increased flexibility in the utilization of their pumping equipment. Equipment substitutions, since incompatible with the district's standardization program, will not be considered.

BID SUBMITTAL

This submittal shall include all necessary information for the proper determination of the acceptability of the proposed substitution and shall not necessarily be limited to the following.

A. Complete description of the equipment, system, process, or function, including a list of system components and features, drawings, catalog information and cuts, manufacturer's specifications, including materials description.
B. Performance data and curves, and horsepower requirements.
C. Outside utility requirements, such as water power, air, etc.
D. Functional description of any internal instrumentation and control supplied including list of parameters monitored, controlled, or alarmed.
E. Addresses and phone numbers of nearest service centers and a listing of the manufacturer's or manufacturer's representatives' services available at these locations, including addresses and phone numbers of the nearest parts warehouses capable of providing full parts replacement and/or repair services.
F. A list of five installations in the states where similar equipment by the manufacturer is currently in similar service; include contact name, telephone number, mailing address of the municipality or installation, engineer, owner, and installation contractor; if five installations do not exist, the list shall include all that do exist, if any.
G. Detailed information on site, architectural, structural, mechanical, plumbing, electrical, and control, and all other changes or modifications to the design and construction work necessary to adapt the equipment or systems to the arrangement shown and/or functions described on the drawings and in the technical specifications. This shall include plan view and section sketches illustrating any additional space requirements necessary to provide the minimum adequate clear space within and around the equipment for operation and maintenance, as shown on the drawings and specified.
H. All differences between the specifications and the proposed substitute equipment shall be clearly stated in writing under a heading of "differences".
I. Other specified submittal requirements listed in the detailed equipment and material specifications.
J. A completed and signed copy of the “Pump Station Certification Affidavit” which follows.

EVALUATION

Approval of the substitution to bid as an alternate shall in no way relieve the contractor from submitting the specified shop drawings for approval or complying fully with all provisions of the specifications and drawings.

If substituted equipment is accepted, the contractor shall, at his own expense, make any changes in the structures, piping, electrical, etc. necessary to accommodate the equipment. If engineering is required due to substitution of alternate equipment, the contractor shall pay for all engineering charges.

To receive final consideration, copies of the manufacturers' quotations for the equipment may be required to document the savings to the satisfaction of the engineer. It is the intent that the owner shall receive the full benefit of the savings in cost of equipment and the contractor's bid price shall be reduced by an amount equal to the savings. In all technical and other evaluations, the decision of the engineer is final.

STATION MONITORING PACKAGE

Pump overload trip alarm from starter overload trip
Time delay to prevent simultaneous pump starts
Phase failure/reversal monitor with pump motor shutdown on fault
Control power failure alarm

COLD CLIMATE PACKAGE

For cold weather operation, the station shall be provided with a 1300/1500 watt, dual range auxiliary heater with automatic circulating fan, thermostat control and an On/Off switch. The auxiliary heater shall be plugged into the station’s duplex receptacle. In addition, the fiberglass cover shall have a minimum of 1” thick urethane insulation, protected by fiberglass, with an “R” value of 7 or more. Also, the priming system shall be interlocked with the station temperature sensor so that, should the station ambient temperature fall below a pre-set minimum, solenoid valves shall open the priming system to atmospheric pressure, when the pumps are not running, allowing the liquid in the pumps and piping to drain back into the wet well, preventing freezing.

ENHANCED ALARM PACKAGE

A timer circuit shall be provided in the control panel to signal unauthorized entry into the pump station. The timer shall be activated whenever the fiberglass cover is opened. A key operated switch shall be provided on the station control panel to provide authorized personnel a means to deactivate the alarm before the timer completes its cycle. In addition to the High Water Alarm, the level control system shall be capable of indicating a Low Water Alarm. The station control panel shall also be provided with a maintained contact, manually operated, red mushroom head Emergency Stop Button in an easily accessible position on the top of the control panel to shut down the main pumps and remove power from the control circuits. Actuation of the switch shall also signal an alarm condition. This switch may also function as an emergency operator assist alarm, and provide means for testing the alarm system.

SECTION 1 - ALARM SENSORS

LOW WET WELL LEVEL ALARM

An adjustable displacement switch shall be provided to sense a low water level condition. The switch shall hang into the wet well and shall activate a contact to indicate the low water condition.

PHASE MONITOR

A relay with double pole, double throw contacts shall be provided to monitor and protect against phase loss (single-phasing), under voltage (brownouts) and phase reversal (improper sequence). It shall automatically reset when three-phase service returns to normal.

MOTOR CURRENT MONITORS

Motor current readings shall be displayed on separate panel mounted analog meters for each pump. Current transformers and associated circuitry shall be provided in the panel.

SINGLE-PHASE POWER MONITOR

A relay shall be provided to monitor the 120-Volt single-phase control power supply and initiate an alarm on loss of power. It shall automatically reset when the single-phase service returns to normal.

DEDICATED PUMP PRIME FAILURE

A time delay relay shall be connected to each vacuum pump. Contacts shall be provided to automatically shut down the operating vacuum pump, allow starting of the next pump in the operating sequence and signal an alarm on excessive vacuum pump operating time. Contacts shall be provided for transmitting an alarm signal.

OPERATOR ASSIST ALARM

The station control panel shall be provided with a maintained contact, manually operated, red mushroom-head Operator Assist Alarm Button in an easily accessible position on the control panel to signal emergency operator assistance is required. It also may be used to provide means for testing the alarm system.

UNAUTHORIZED ENTRY ALARM

A timer circuit shall be provided in the control panel to signal unauthorized entry into the pump station. The timer shall be activated whenever the fiberglass cover is opened. A key operated switch shall be provided on the station control panel to provide authorized personnel a means to deactivate the alarm before the timer completes its cycle.

SECTION 2 - ALARM INDICATORS

120V ALARM LIGHT

A vapor-proof light fixture with 50-watt lamp for outdoor pole mounting shall be provided with a red globe and guard.

120V ALARM LIGHT WITH FLASHER

A vapor-proof light fixture with 50-watt flashing lamp for outdoor pole mounting shall be provided. The light shall flash during alarm conditions. The fixture shall be complete with a red globe and guard.

120V ALARM BELL
A vibratone-type bell mounted on a weather-tight box suitable for pole mounting shall be provided.

120V ALARM HORN
A vibratone-type horn mounted on a weather-tight box suitable for pole mounting shall be provided.

12V TRICKLE CHARGER
Storage batteries and charger shall be supplied to furnish power for operating alarm annunciators in cases of power failure. The storage batteries (Two 3-cell, 6-volt) shall be maintenance-free lead-calcium battery concealed in high impact, heat-resistant and permanently sealed containers. The battery charger shall be solid-state, capable of restoring battery to full charge within 12 hours after a discharge, not exceeding 1.5 hours. Brownout protection is standard, and will activate the unit when AC line voltage drops below 85 volts.

12V ALARM LIGHT
A vapor-proof light fixture with 50-watt lamp for outdoor pole mounting shall be provided with a red globe and guard.

12V ALARM LIGHT WITH FLASHER
A vapor-proof light fixture with 50-watt lamp for outdoor pole mounting shall be provided with a red globe and guard. The light shall flash during alarm conditions.

12V ALARM BELL
A vibratone-type bell mounted on a weather-tight box suitable for pole mounting shall be provided.

12V ALARM HORN
A vibratone-type horn mounted on a weather-tight box suitable for pole mounting shall be provided.

REMOTE MOUNTED AUTOMATIC RESET ALARM SILENCE SWITCH
A momentary contact alarm-silencing switch mounted in a weatherproof box suitable for pole mounting shall be provided. The alarm shall automatically be reset when the alarm condition is removed.

PANEL MOUNTED AUTOMATIC RESET ALARM SILENCE SWITCH
A momentary contact alarm silencing switch mounted on the control panel shall be provided. The alarm shall automatically be reset when the alarm condition is removed.

PANEL MOUNTED MANUAL RESET ALARM SILENCE SWITCH
A manual alarm silencing switch mounted on the control panel shall be provided. The switch shall be manually reset when the alarm condition is removed.

REMOTE ALARM CONTACTS
In addition to the common, powered local alarm connection, individual unpowered contacts shall be provided and wired to a terminal strip for field connection to a remote alarm monitoring system (not included).

TEST UNIT WITH BATTERY FOR MULTI-SENSOR CHECK VALVE SWITCH [FOR USE WITH RELAY LOGIC CONTROLS.]
To test or set the multi-sensor check valve switches using the built-in LED light with Relay Logic control systems, a separate hand held battery pack with connecting cord and plug shall be provided. This is to enable the operator to accurately set the trip point of the switch manually, by means of the built-in test light on the multi-sensor.

DISCRETE CONTACTS FOR ALARM DIALER INTERFACE (DIALER NOT INCLUDED)
Provisions shall be made within the pump station to facilitate the field installation of an alarm dialer, which is to be furnished and installed by others. The alarm dialer shall be as described elsewhere in these specifications.
The factory built pump station shall be provided with a mounting bracket approximately 12 inches by 10-5/8 inches to attach

and support the alarm dialer, near the station control panel, beneath the fiberglass enclosure. In addition, openings for conduit connections shall be provided in the bottom of the station control panel and through the side of the station base, to facilitate wiring of the alarm dialer input, output and power connections. In addition to the powered common local alarm contact, the station control panel shall have terminal strip connections for fault-opening alarm contacts to provide up to 8 discrete alarm input signals (depending on the packages and options selected) to the dialer and shall also include terminal strip connections for a 1/60/120 volt power source, on a separate 15-amp circuit, to power the dialer. Wiring of the dialer shall be done by others during installation of the station in the field.

SECTION 3 - WET WELL ACCESSORIES

WET WELL FALL PROTECTION BARRIER

A fall protection safety barrier to prevent personnel, tools or equipment from falling through the manway opening and into the wet well when the manway cover is in the raised position, shall be provided by the station manufacturer for field installation in the wet well by the installing contractor. The fall protection barrier shall be constructed of aluminum bar grating and shall cover the area beneath the manway cover. Stainless steel hinges and a lifting handle shall be provided for convenience. When fully open, the fall protection safety barrier can be latched open for safe entering and exiting of the wet well. All components shall be constructed of stainless steel except for the aluminum grating. The barrier shall be capable of holding a 400-pound concentrated load, when in the Closed position.

The wet well fall protection barrier kit shall include the aluminum grating barrier, 304 SST hinges, 304 SST mounting brackets, 304 SST hardware, the required number of 1/2" diameter 304 SST wedge anchors for the specific wet well kit size and a complete set of instructions for installation of the fall protection barrier in a foot diameter wet well.

SECTION 4 - MECHANICAL

ADDITIONAL SPARE MECHANICAL SEALS

In addition to the one standard spare mechanical seal, additional spare mechanical seal(s) shall be provided. The spare seal(s) shall be packed in a suitable container and shall include complete installation instructions.

REMOVE FIBERGLASS ENCLOSURE

The fiberglass enclosure, station ventilating blower, and 500-watt electric heater shall not be provided.

REMOVE MANWAY ACCESS COVER

The aluminum treadplate manway access cover, stainless steel piano hinge and hardware shall not be provided.

EMERGENCY PUMPING CONNECTION

The common discharge pipe of the pump station shall be fitted with a branch with a [3"(75 mm), 4" (100 mm)] plug valve and male quick-connect fitting, with cap, as shown on the drawings, to facilitate connection of a portable emergency pump to the force main, to bypass the pump station. The emergency pumping connection shall be housed within the station's fiberglass cover.

SECTION 5 - CONTROL PANEL

MAIN CIRCUIT BREAKER

A main circuit breaker shall be installed in the control panel to provide over-current protection for the station, and shall be capable of being used to disconnect the three-phase power to the pump station.

The breaker shall be operable without opening the panel, and shall be interlocked with the panel door. It shall be capable of being padlocked in the "Off" position.

MAIN DISCONNECT SWITCH

A main disconnect switch shall be provided to disconnect the three-phase power to the pump station. The switch shall be operable without opening the panel, and shall be interlocked with the panel door. It shall be capable of being padlocked in the "Off" position.

TIME DELAY
The control system shall provide for a time delay to prevent simultaneously starting the pump motors after power failure.

GENERATOR INTERLOCK
Provisions shall be made in the control circuit of the lift station to facilitate locking out the standby pump when the emergency generator set is powering the station. An interlock consisting of a normally closed auxiliary contact shall be supplied with the emergency generator controls by the generator manufacturer. This normally closed contact shall be wired to the terminal blocks provided in the lift station control panel by the lift station manufacturer. The interconnecting wiring shall be supplied and connected by the installing contractor.

INTRINSICALLY SAFE CONTROL
Intrinsically safe relays to provide low current isolated switching for the float switches shall be provided.

NON-MERCURY FLOAT SWITCHES
The level control float switches shall be of the mercury free design, operated by a rolling steel ball traveling back and forth within a switch tube, to actuate a snap action switch, all mounted in a sealed plastic float housing, supported by a watertight cord. An integral weight shall cause inversion on submergence.

SOLID-STATE STARTERS
UL listed, solid-state reduced voltage starters shall be supplied. The starters shall be capable of a soft start and soft stop. The starters shall have built in overload protection as well as built in bypass contactors. One set of Form C auxiliary contacts shall be supplied on the starter. The starters shall have a built-in Digital Signal Processor utilizing a low impedance run circuit. The starters shall be easily programmable by using a standard screwdriver.

NEMA STARTERS
NEMA rated magnetic across-the-line starters with overload protection for each phase shall be provided for each pump motor to give positive protection against phase unbalance, thermal overload, phase loss and ground fault.

STAINLESS STEEL PANEL
The control equipment shall be mounted in a NEMA-type 4X stainless steel enclosure with two-section, piano hinged, lockable doors.

RUNNING TIME METER FOR PARALLEL OPERATION
A third running time meter shall be supplied to show the number of hours of operation with both pumps running in parallel. The meter shall be enclosed in a dust and moisture-proof molded plastic case. The flush mounted dial shall register in hours and tenths of hours up to 99,999.9 hours before repeating.
The meter shall be suitable for operation from a 115-volt, 60-cycle supply.

PUMP RUNNING LIGHTS
A green panel light to indicate “Pump On” shall be provided for each main pump.

BASE1-BASE2-AUTO ALTERNATE SELECTOR SWITCH
A 3-position selector switch shall be mounted on the face of the control panel to allow selection of either pump as the lead pump, or to allow for automatic alternation.

SURGE PROTECTIVE DEVICE
A surge protective device for lightning and surge protection with an internal automatic discharge circuit and rated for three-phase service shall be provided.

TIME DELAY
The pump control system shall provide for a time delay to prevent simultaneously starting the pump motors after power failure.

SEQUENTIAL ALTERNATION
In lieu of the timed alternation system, provisions shall be made to alternate the pumps at the completion of each pumping cycle.

EXTRA 20 AMPERE CIRCUIT BREAKER(S)
The main control panel shall contain spare 20 amp, single pole 120v circuit breaker(s) to power external equipment supplied by others.

ADD-A-PHASE INTERFACE
Terminals shall be provided in the lift station control panel to facilitate connection to an external Add-A-Phase phase converter unit.

ROTO PHASE INTERFACE
Terminals and a time delay to prevent simultaneously starting the pump motors after power failure shall be provided in the lift station control panel to facilitate connection to an external Roto Phase phase converter unit.

SECTION 6 - ENVIRONMENTAL

AUXILIARY STATION HEATER
A 1300/1500 watt, dual range, electric heater with automatic circulating fan, thermostat control and an On/Off switch is to be provided. The heater is to be operated by connection to the station convenience receptacle.

INSULATED HOOD
The fiberglass cover shall have a minimum of 1" thick urethane insulation, protected by fiberglass, with an "R" value of 7 or more.

SECTION 7 – MISCELLANEOUS

TOOLKIT
A metal toolbox complete with the following tools shall be provided. This complement of tools shall include all tools necessary to replace the pump mechanical seal.

9/16" x 1/2" Box End Wrench
3/4" x 5/8" Open End Wrench
15/16" x 1" Open End Wrench
1-1/8" Socket
8" T-Handle 11" x 1/2" Drive
1/2" x 5-1/2" Drive Extension
6" Pipe Wrench
#3 Rawhide Mallet
Ratchet-Type Hoist
Motor Lifting Bar
Lint-Free Cloth
Multi-Purpose Grease

SECTION 15185

EXECUTION

PART 1 – GENERAL

1.01 INSPECTION

A. Inspect all equipment upon arrival at job site and prior to installation. Notify manufacturer of any damage and/or shortage.
B. Inspect concrete mounting pads and anchor bolts for correct size and alignment prior to installation.

1.02 PREPARATION

A. Make corrections and/or repairs as required for items inspected and found to be deficient.

1.03 INSTALLATION

A. Install pumps and accessories in strict accordance with the manufacturer's instructions.

1.04 FIELD QUALITY CONTROL

A. The manufacturer's field engineer or representative shall inspect and check the installation after erection and be on hand for initial start-up of the equipment for a period of at least three (3) days. He shall also instruct operating personnel in the operation and maintenance of the system.

1.05 ADJUSTING AND CLEANING

A. Adjust equipment as required and within limits of manufacturer's instructions for proper alignment.
B. Apply proper type and quantity of lubricants for short term storage or start-up operation as applicable.
C. Clean equipment of any foreign matter or substances.
D. Field paint all components to be painted in accordance with manufacturers recommendations.

1.06 PROTECTION

A. After installation and painting protect the equipment from any damage by work of other trades. Repair any damage that nevertheless may occur.

END OF SECTION

SECTION 15190

SERVICE AND WARRANTY

PART 1 – GENERAL

1.01 SERVICE

A. The pump manufacturer shall have an authorized factory service center capable of completely servicing the proposed pumps within 100 miles of the project site. The pump manufacturer shall have a ***factory direct*** service center/stocking facility capable of completely servicing, and which stocks identical complete drive units, and spare parts for, the proposed pumps within 100 miles of the project site.

1.02 PUMP WARRANTY

A. The pump manufacturer shall provide prorated warranty for the units supplied to the Owner against defects in material and workmanship for a period of at least five (5) years or 10,000 operating hours in writing under the operating conditions presented by this project. Pump manufacturer shall demonstrate ability to support claimed warranty coverage by meeting all requirements of Section 4.01 of this specification.

B. The manufacturer guarantees the installation to be free from clogging when pumping sewage and wastewater containing solids and debris normally found in domestic wastewater. This guarantee is extended to the original owner for a period of 12 months from the date of startup of the equipment by the Local Authorized Distributor. Should the pump impeller clog with typical solids and/or debris normally found in domestic wastewater during this period, the manufacturer shall reimburse the owner for reasonable cost to remove the pump, clear the obstruction and reinstall the affected pump unit. The manufacturer reserves the right to inspect the pump station, pump units and possibly modify the pump unit, if deemed necessary, to mitigate any further occurrence of pump clogging at no cost to the owner.

END OF SECTION