

SPECIFICATIONS

City of Memphis Lift Station Rehab for SARP 10

A2H No. 21117.02

Prepared By:

A2H

ENGINEERS • ARCHITECTS • PLANNERS

3009 Davies Plantation Road
Lakeland, TN 38002

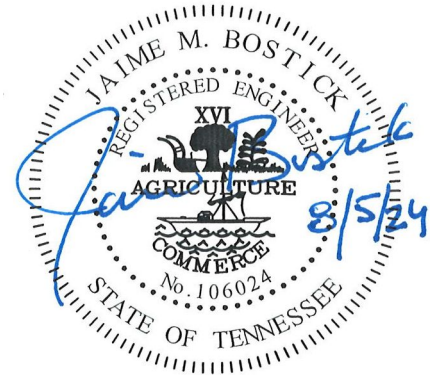
901.372.0404
www.A2H.com

A2H, Inc.

SECTION 000107
SEALS PAGE

CIVIL ENGINEER:

JAIME BOSTICK, PE
A2H, INC.
3009 DAVIES PLANTATION ROAD
LAKELAND, TN 38002
PHONE: (901) 372-0404



CIVIL ENGINEER:

BRADLEY J. DAVIS, PE
ABES ENGINEERING, INC
2500 MT. MORIAH RD H229
MEMPHIS, TN 38115
PHONE: (901) 340-3011



ELECTRICAL ENGINEER:

STEPHEN P. MAY, PE
A2H, INC.
3009 DAVIES PLANTATION ROAD
LAKELAND, TN 38002
PHONE: (901) 372-0404



END OF SECTION

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**SECTION 01551
TRAFFIC CONTROL FOR CONSTRUCTION WORK ZONES**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. 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

- A. A Traffic Control Plan shall be submitted to the Program Manager, including the following items:
 - 1. Outline of permit acquisition procedure for lane closures.
 - 2. Methods for proper signing and barricades, which comply with local requirements and the City.
 - 3. 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.
 - 4. The Contractor will be required to deliver a sample primary/arterial road Traffic Control Plan for review by the City.
 - 5. 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.
 - 6. 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.
 - 7. The Contractor is also responsible for acquiring all necessary disposal and/or landfill site permits required to perform this work.

8. 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 Specification Section 02891 Paragraph 2.02 F.

- A. Traffic Cones.
1. 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.
1. 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 of vertical panels shall be according to Section 6C of the MUTCD.
- C. Drums.
- D. 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.
- E. Barricades.
1. 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.
- F. High Level Warning Devices.
1. 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.
- G. Warning Lights.
1. 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.

| | <u>Type A Low Intensity</u> | <u>Type B High Intensity</u> | <u>Type C Steady Burn</u> |
|--------------------------|-----------------------------|------------------------------|---------------------------|
| Lens Directional Faces | 1 or 2 | 1 | 1 or 2 |
| Flashing Rate per Minute | 55 to 75 | 55 to 75 | Constant |

| | | | |
|---|--------------|-------------|--------------|
| Flash Duration ¹ | | | |
| Minimum Effective Intensity ² | 10% | 8% | Constant |
| Minimum Beam Candle Power ² | 4 Candelas | 35 Candelas | 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 90 on each side of the vertical axis and 50 above and 50 below the horizontal axis. | | | |

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 GENERAL REQUIREMENTS.

A. Traffic Control Plan

1. A Traffic Control Plan shall be developed by the Contractor 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 Contractor 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. Personnel

1. The Contractor 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 Contractor shall make known the name of the person providing the surveillance at the preconstruction conference.

C. Traffic Control Devices

1. 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. Construction Signs

1. All construction signs shall be erected such that all supports are vertical, sign panels generally perpendicular to the travelway 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.

2. 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 Contractor must advise and have the approval of the Purchaser prior to installing or removing traffic control devices from the project.
 3. 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.
 4. 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 Contractor'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 Contractor will be responsible for investigating, procuring, and bearing the expense of a continuous power source whether by battery, generator, or commercial A.C. supply.
- E. Flaggers
1. Flaggers with proper attire and flags shall be provided when ordered by the City or Purchaser or when the Contractor 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.
- F. 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 Contractor, 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 Contractor.

3.02 MAINTENANCE

- A. The Contractor 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.

- A. 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 CONTROL DEVICES FOR CONSTRUCTION WORK ZONES.

- A. Furnishing, erecting, and maintaining traffic control devices and other incidentals and personnel required for handling traffic safely through construction work zones will be paid for on a lump sum basis 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

- A. 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 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.
- B. Payment will be made under:

| Item No. | Pay Item | Pay Unit |
|------------|-----------------|----------|
| 01551-5.01 | TRAFFIC CONTROL | Lump Sum |

END OF SECTION

**SECTION 01610
BASIC PRODUCT REQUIREMENTS**

PART 1 – GENERAL

1.01 MATERIALS AND EQUIPMENT

- A. All materials and permanently installed equipment (for example, traffic signalization equipment, sewer pumps, and other such items) furnished by the Contractor 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.

1.02 EQUIVALENT MATERIALS AND EQUIPMENT

- A. The General Conditions allow for the substitution of equivalent materials and equipment, with the written approval of the Purchaser.
- B. 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.
- C. If the Contractor 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 Contractor 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.

1.03 LIST OF MAJOR EQUIPMENT AND MATERIALS

- A. The Contractor 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.

1.04 SOURCE OF SUPPLY

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

1.05 SAMPLES AND TESTING

- A. 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.
- B. 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.

1.06 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 Contractor shall not plead deception or misunderstanding because of variation from these quantities. Unless otherwise provided in the Contract Documents, payment to the Contractor 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 Contractor 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.

PART 2 – MEASUREMENT**2.01 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 avoirdupois.
- 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 Specifications hereof, or of other Specifications provided for the Work.
- D. 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.
- E. 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.
- F. In all cases where measurement of materials is based on certified weights, the Contractor 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.
- G. 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.
- H. 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.
- I. 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 | 0.01 CY |
| 1,000 SF Unit | 0.1 Unit |

END OF SECTION

**SECTION 02230
SITE CLEARING**

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. 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 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 – 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 MEASUREMENT

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

PART 5 – PAYMENT

5.01 PAYMENT FOR WORK

- A. 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.

Payment will be made under:

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

END OF SECTION

**SECTION 02530
SEWER PIPE INSTALLATION**

PART 1 - GENERAL

1.01 SCOPE

- A. This Work will consist of the construction of sanitary sewers, siphons, and service connections of the kinds and dimensions shown on the Plans, stipulated in the Contract Documents, or as directed by the Purchaser. The construction will be accomplished by these Specifications and in conformity with the lines, grades, and details shown on the Plans or established by the Purchaser. The Contractor will perform all work necessary to complete the Contract with the best modern practice. Without specifications that state the quality of any work, the Contractor is required to perform such items using first-quality construction. Unless otherwise provided, the Contractor will 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 Contractor will 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 will be considered defective and will be removed immediately from the site.
- B. Higher Strength Pipe
1. The Contractor 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 will be the standard product of an established, reputable manufacturer made in a permanent plant. Suppliers for each material to be used by the Contractor will be subject to approval by the Purchaser. No material will 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 will be submitted for examination when so specified or requested. All material to be used in the work will be sampled, inspected, and tested by current ASTM specifications, or other standard specifications approved by the Purchaser. The Contractor will furnish the Purchaser with three copies of certified reports from an accredited 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 will show the laboratory's stamp. The performance or cost of all testing is the responsibility of the Contractor.
 2. The Contractor will notify the Purchaser before any deliveries of material and will make whatever provisions are necessary to aid the Purchaser in the inspection and culling of the material before installation.
- E. Storage
1. The Contractor will 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 will be kept free from dirt and foreign matter. PVC pipe, fittings, and adapters stored outside and exposed to sunlight will be covered with an opaque material with proper ventilation.

F. Ductile Iron Pipe and Fittings

1. 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.

G. Ductile Iron Couplings

1. Ductile iron couplings for use in connecting of smooth end joints of cast iron, ductile iron, asbestos cement, steel, PVC or other types of pipe must be capable of fitting this variety of pipes with one set of follower flanges or end rings.
2. Sleeve shall be of Ductile Iron ASTM A536. Ends shall have a smooth inside taper to provide uniform gasket seal. Sleeve shall be given a shop coat of oil-modified urethanes, corrosion resistant paint, or epoxy coating.
3. Follower flanges or end rings shall be of the thickness determined by the coupling size, and shall be ductile iron, ASTM-536. Flanges shall be identified by a color-coded shop coat finish.
4. Gaskets shall be compression – type, formed with Virgin Styrene Butadiene Rubber (SBR,) ASTM D2000 3 BA715, and compounded with ingredients to produce permanence and resistance to set after installation. O.D. range shall be imprinted/molded on the gasket in permanent ink (Minimum).
5. Bolts and Nuts shall be of high-strength, low-alloy steel, with nominal coarse thread, and hex nuts with black finish.
6. Dimensions and minimum stress values shall be in accordance with AWWA/ANSI C111/A21.11.
7. Manufacturers and Products:
 - a. Smith-Blair, Inc. 441
 - b. JCM Industries 210
 - c. Romac Industries, Inc. 501
 - d. Or Equal

H. Polyvinyl Chloride (PVC) Gravity Pipe and Fittings (8-15 inch Diameter)

1. All PVC gravity pipe and fittings 8-15 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 will conform to the requirements of ASTM D 3034. The standard dimension ratio (SOR) will be SOR 26 (Type PSM). PVC resin will conform to ASTM D 1784 cell class 12454C. A different cell class will be allowed only if the material meets the requirements of a superior cell class than 12454C. Fittings for PVC gravity sewer pipe will 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 will be no less than the respective minimum thicknesses for the equivalent pipe. All fittings will be compatible with the pipe to which they are attached.
2. All PVC gravity pipe joints will be gasketed bell and spigot push-on type conforming to ASTM D 3212, unless directed otherwise in these Specifications. Gaskets will be part of a complete pipe section and purchased as such. Lubricant will be as recommended by the pipe manufacturer.
3. Combination Air Valves

- I. The Combination Air Valve shall consist of a combination of an air and vacuum large orifice and an automatic small orifice in a single body. The valve must be designed to operate with liquids carrying solid particles. The valve shall discharge air during the filling or charging of the
 1. system and admit air to the system while being emptied of liquid and discharge accumulated air from the system while it's under pressure and operating. Each of these valves shall be designed to separate the liquid from the sealing mechanism. The valve shall have a working pressure range up to 150 psi or as specified on the plans. Combination Valves shall be A.R.I. or approved equal.
 - a. The manufacturer shall certify venting capacity and provide three copies of installation and maintenance manuals for each type of Combination Air Valve supplied.
 - b. The Manufacturer shall guarantee all items specified to be free from defects in design, materials and workmanship for one year from the date of acceptance. During the guarantee period, the Manufacturer shall furnish and install replacement parts for any defective component at no additional cost.
- J. Check Valves, Gate Valves and Ball Valves
 1. All check valves shall have external arms so that the valve may be opened and closed by hand. Check valves shall be controlled closing swing check valves and shall be Golden Anderson Series 250, or Valve and Primer Series 6000, or as approved . Each check valve shall have a cast iron body, stainless steel springs, stainless steel hinge pins and stops, Teflon spring and hinge bearings and standard trim for IBBM construction. All wetted components shall be 316 stainless steel. Each check valve shall have Buna N seals.
 2. All check valves shall be class 125 vertical or horizontal swing type with iron body and flanged ends.
 3. Knife gate valves will be manufactured by Red Valve Company, Inc, Pittsburgh, PA; and shall be their Standard Flexgate, or approved equal. Knife gate valves must conform to AWWA C-504 requirements. The shaft shall be constructed of Type 304 stainless steel. The knife gate shall be Type 316 stainless steel. The valve seat shall be a resilient, mechanically retained, field replaceable, polytetrafluoroethylene elastomer. The upper and lower bearings shall be self lubricating Teflon. The valve shall be equipped with a handwheel.
 4. Bonneted knife gate valves shall be Pratt LVC Figure 193 or approved equal.
 - a. Valves shall be of the Bonneted Knife Gate Valve type, rated for 150 PSI CWP. Flanges shall be drilled and tapped to ANSI B16.5, Class 150 pound standard with raised faces. Flange raised face shall be machined using serrated-spiral or serrated-concentric grooves with a 125-250 RMS finish. Valve bodies shall be 316 stainless steel.
 - b. The valve bonnet shall be fabricated with 316 stainless steel liner, packing box and bonnet flange raised face. Bonnet flange and stiffeners shall be 316 stainless steel. A gate wiper shall be used between the bonnet flange and the body top flanges. The wiper material shall be UHMWPE.
 - c. Valve shall have 316 stainless steel gate and integral cast stainless steel seat in the valve body. Gate shall be of design and thickness to withstand full 150 PSI rated pressure without permanent deflection to the gate. Gate shall have a rounded, beveled bottom. Seat and gate shall have a fully machined finish for one way shutoff. Minimum of two gate wedges shall be provided to assist seating of the gate against the seat in the lower half of the valve body. Gate guides shall be provided in the upper half of the valve body.
 - d. Packing gland shall be cast stainless steel. Packing shall be Teflon lubricated synthetic packing with a minimum of 4 rows of packing. Packing gland bolts, studs and nuts shall be 304 Stainless steel.

- e. Valve yoke shall be cast 304 stainless steel. Yoke shall be the flat top design to allow bolt-on field installation or conversion of actuators without welding or machining. Valve stem shall be 316 stainless steel (same material grade as bonnet liner) with full ACME threads. Stem nut shall be bronze. Stem nut shall be enclosed by the use of a cast stainless steel retainer.
- f. Valves shall be designed, manufactured and tested to MSS SP-81 standard or AWWA C520 standard.
 - 1) Wedge gate valves will be resilient wedge gate valves as manufactured by Mueller Co., or approved equal. Wedge gate valves must conform to AWWA C 509 or AWWA C 515 and will be either series 2360 or series 2361.
 - 2) All ball valves for 2 inch and 3 inch diameter fittings shall be full port, brass ball valves, shall be rated to 125 psi minimum, and shall meet the requirements of NSF/ANSI 61/8. Ball valves will have threaded connections and blowout proof stems. Ball valves will be Series FBV-3C as manufactured by Watts, or as approved.
 - 3) Valve manufacturer shall furnish certification that each valve has been subjected to a hydrostatic water pressure twice the pressure class and that each valve is free of defects. The valve manufacturer shall guarantee all items specified to be free from defects in design, materials and workmanship for one year from the date of acceptance. The manufacturer shall, during the guarantee period, furnish and install replacement parts for any defective component at no additional cost.

K. Adapters and Couplings

- 1. At the direction of the Purchaser, a connection of sanitary sewer pipes, 6 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 will be manufactured of an approved preformed elastomeric material conforming to applicable sections of ASTM Standards C 425, C 564, C1173, D 3212, and D 5926. Mechanical couplings or adapters will 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 240. If a stainless steel shear band is not used a concrete collar is required. Each connector and adapter will bear the manufacturer's name and required markings. Installation will 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 Specification Section 02530 Paragraph 3.09.C. Mechanical connectors meeting the above requirements may be used at the direction of the Purchaser.

L. Crushed Limestone

- 1. Crushed limestone will 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 | 20 | 0 | 0 |
| | | 100 | 55 | 10 | 5 |

2. Crushed limestone meeting the requirements of the Tennessee DOT Standard Specifications for Road and Bridge Construction, size No. 57 Coarse Aggregate will be used as directed by the Engineer or as shown on the plans. Size No. 57 Coarse Aggregate will meet 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 |
| 57 | 100 | 95 | 25 | 0 | 0 |
| | | 100 | 60 | 10 | 5 |

M. Pit Run Gravel

1. Pit run gravel will 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. | 2-1/2' | 2" | 1-1/2" | 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 will 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 will be known as the binder. The binder aggregate will consist of hard durable particles of limestone or sound siliceous material. Shale aggregate or pipe clay binder will not be acceptable. The percent of silt will 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 will comply with these Specifications. The mixing will be done uniformly, and blending of material on stockpiles or in the pits by bulldozers, clamshells, draglines, or similar equipment will not be permitted.

N. Non-Shrinking Grout

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

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, will be considered unclassified excavation despite the nature of the material and objects excavated and will not be measured or paid for separately except as specifically noted. Pavement removal and replacement will be accomplished as specified in Specification Section 02950.
- B. Trench Excavation
1. All trenches will be open cut unless otherwise shown on the Plans. Tunneling, boring, or jack ing 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 will be hand excavated so that the pipe is bedded on a firm, undisturbed subgrade.
 3. No more than 300 feet of trench will 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 Contractor in writing.
 4. The width of trenches below a level 1 foot above the outside top of pipe will 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 will be 36 inches. For 18 inch diameter pipes, the width of trenches below a level 1 foot above the outside top of pipes will 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 will 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 will be made at the Contractor's expense to compensate for the additional load upon the pipe.
 5. The sides of the trench will be as nearly vertical as possible. The bottom of the trench will be carefully graded, formed, and aligned according to City of Memphis Standard SST-3 and to the satisfaction of the Purchaser before sanitary sewers are laid.
- C. Other Excavation
1. Undercut Excavation:
 - a. Undercut excavation will consist of removing and disposing of unsatisfactory material below the grade established on the Plans for sanitary sewers, structures, and manholes. No undercut excavation will be done without prior authorization of the Purchaser. The limits of undercut excavation will be determined by the Purchaser who will be present during the undercut operations.
 2. Undercut areas will be backfilled with No. 67 limestone or other aggregate approved by the Purchaser to the grade established on the Plans. The backfill will 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. Undercut backfill will be encapsulated in geotextile fabric conforming to Specification Section 02370 2.01.C.
 3. Unauthorized Excavation Below Subgrade or Outside Limits:
 - a. Any unauthorized excavation and subsequent removal and backfilling beyond the lines and grades shown on the plans will 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 will be backfilled according to Specification Section 02530 Paragraph 3.02.C.2.
- 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 Plans, 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 Change Order 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 will 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 Change Order will be prepared covering the backfilling and restoration of the abandoned excavation. Backfilling and restoration of the abandoned excavation will be accomplished according to the appropriate section of these Specifications .
 3. Filling a portion of existing excavation to meet changed grades will be accomplished according to Specification Section 02530 Paragraph 3.11.
 4. If a change in a location and/or grade is authorized in writing by the Purchaser at the written request of the Contractor , the Contractor will not receive any additional compensation for the changed work . 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 as appropriate will be used to develop payment.
- E. Disposition of Excavated Material
1. Excavated material suitable for backfill will be stored no closer than 2 feet from the edge of the excavation. Excavated material will not obstruct crosswalks, sidewalks, driveways, street intersections, nor interfere unreasonably with travel on streets. Gutters or other surface drainage facilities will not be obstructed. The Contractor must provide access to fire hydrants, mail boxes, sewer and conduit manholes and similar utility or municipal service facilities as required. Excavated material intended for backfill will be stored in a way that minimizes loss of excavated material due to erosion. The Contractor 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 will be removed from the site and disposed of by the Contractor. If the Contractor 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 Contractor in advance. A certified copy will be given to the Purchaser. No surplus or excess material will be deposited in any stream channel nor anywhere that would change preconstruction surface drainage.
- F. Control of Water
1. The Contractor will keep all excavations free of water . If the trench subgrade consists of good soil in good condition at the time of excavation , it will be the Contractor'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 will be provided by the contractor. Dewatering of trenches will be incidental to trench excavation .The Contractor will avoid producing mud in the trench bottom by his operations. If necessary or so ordered by the Purchaser, the Contractor will 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 bedding, laying, jointing, and the placing of concrete or masonry will be done in a water free trench or excavation. Trenches will be kept clear of water until pipe joints , concrete and masonry have set and are resistant to water damage. The water will 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 will be kept in operation, or their flows will be satisfactorily diverted and provided for during construction. Any facilities disturbed during construction will be restored to the satisfaction of the Purchaser.
- G. Excavation Around Obstructions
1. The Contractor will perform all excavation by hand where excavation by machinery would endanger trees , structures, or utilities that otherwise might be saved by hand excavation.

2. The Contractor will cautiously excavate test holes 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.
- H. Excavation for Manholes and Special Structures
1. The Contractor will be responsible for performing the Work according to the lines and elevations shown on the Plans or as directed by the Purchaser. The Contractor will 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 will 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 will not exceed 2 feet from the outside of the masonry or concrete work . If the excavation exceeds this limit, the Contractor will be required to backfill the entire space around the structure with pit run gravel compacted as specified in Specification Section 02530 Paragraph 3.11.B.
- I. Special Protection
1. Treacherous Ground:
 - a. When running sand, quicksand, or other treacherous ground is encountered, the work will be carried on with the utmost urgency and will continue day and night should the Purchaser so direct.
 2. Sheet piling and Shoring:
 - a. The Contractor will furnish, place, and maintain sheet piling 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 Contractor will place the sheet piling and shoring without the Purchaser's instructions .
 3. Sheet piling will extend below structure invert a sufficient depth to assure adequate support. In the installation of sheet piling. the use of vibratory type pile drivers (as opposed to impact type) will be limited to sheet piling driven no greater than 5 feet below the invert. The sheeted trench width, as measured between those faces of the sheet piling in contact with the earth trench wall, will not exceed the maximum width of a trench per Specification Section 02530 Paragraph 3.02 .B. Walers and struts will be designed and installed to present no obstructions to proper placement of the pipe, bedding, cradle or encasement, and they will not interfere with the satisfactory installation of the pipe.
 4. Sheet piling, bracing, and shoring will be withdrawn and removed as the backfilling is being done, except where the Purchaser permits the material to be left in place. The Contractor will cut off sheet piling left in place at least 2 feet below the surface and will remove the cut off material from the excavation.
 5. All sheet piling, bracing, and shoring which is not left in place under this provision will be removed in a way that will not endanger the completed work or other structures, utilities, storm drains, sewers, or property. The Contractor will be careful to prevent the opening of voids during the extraction process.
 6. If sheet piling and shoring are not specifically required on the Plans 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 will be carefully backfilled and compacted following trench backfill requirements.
 7. Excess Width of Trench:

- a. If the Contractor is permitted to use equipment that results in wider trenches than specified, approved methods will 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 contractor is 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 will be backfilled and compacted according to ASTM D 2321, and no concrete cradle will be used.
- 8. Underpinning:
 - a. When excavations require underpinning of existing structures, the Contractor will 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 will not relieve the Contractor of his responsibility for protection of the structure and its contents.
- J. Existing Utilities
 - 1. It shall be the Contractor's responsibility to arrange for the location of existing utilities prior to excavation. The Contractor will also be responsible for coordinating the relocation of any existing utilities with the appropriate utility owner.
 - 2. Protection
 - a. The Contractor will protect any storm drain, sewer, or utility within the limits of the construction. The Contractor will proceed with caution and will use every means to establish the exact location of underground structures and facilities before excavating in the vicinity. 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 broken or damaged by the Contractor's operations. All water and gas pipes and other conduits near or crossing the excavation will be properly supported and protected by the Contractor.
 - 3. If the construction requires the removal and replacement of any overhead wires or poles, underground pipes, conduits, structures or other facilities, the Contractor will arrange for such work with the Owner or Owners of the facilities. No additional payment will be made by the City for this work.
 - 4. Sewer and utility services between mains and buildings will be maintained and adjusted as necessary by the Contractor to provide as nearly a continuous operation as can be expected. This will be accomplished in any way that the Contractor chooses, provided the individual service is not interrupted for more than two consecutive hours. The occupants will be notified by the Contractor at least six hours before such service interruptions. When a break occurs, the Contractor will notify the affected occupant(s) of the probable length of time that the service will be interrupted.
 - 5. If existing underground facilities or utilities require removal and replacement for the performance of this work, all replacements will 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 will be the Contractor's responsibility within the limits where the new service line grade blends smoothly with the existing service line grade.
 - 7. The Contractor will 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 bedding will be constructed as shown on the Plans. It will be the Contractor's responsibility to find all underground utilities before construction to insure there are no conflicts with the proposed line and grade. The Contractor's surveyor shall verify the base information on the City's plans prior to commencement of construction. Any discrepancies in the plans 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 Contractor will arrange with the owner of said utility to have it adjusted as required to accommodate the proposed sewer at no additional expense to the City.
- B. Modifications of Existing Sanitary Sewer Facilities
1. Maintenance of Flow:
 - a. Where existing sewer lines are being modified, the Contractor will 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 contractor will provide necessary bypass pumping capacity to carry flow downstream of the section to be modified.
 2. Sewer pipe called for in the Specifications or Plans to be abandoned will be sealed at each end for a minimum distance of 18 inches, or one-half the diameter of the pipe, whichever is greater.
 3. Unless otherwise specified, the pipe will be sealed with a brick bulkhead and/or acceptable cement grout to form a solid watertight plug completely bonded to the pipe. Any sewer manholes to be abandoned will be abandoned per Specification Section 02531 Paragraph 3.03.8.
 4. The Contractor will be allowed to remove pipe to be abandoned if wanted. If the Contractor elects the removal method, all associated costs will be included in the cost for other Pay items.
 5. Connection to Existing Manholes:
 - a. The Contractor will core 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 Plans. Care will be used to avoid unnecessary damage to the existing manhole.
 6. All loose material will be removed from the cut surfaces that will be completely coated with nonshrinking grout before setting the pipe. Before inserting the pipe, a sufficient thickness of grout will 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 will be installed on the pipe according to the manufacturer's recommendations. After setting, all spaces around the pipe will be solidly filled with nonshrinking 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 will be made to provide a smooth, plastered surface for properly channeled sewage flow from the new connection. Plaster on the exterior of brick manholes will be repaired with nonshrinking grout. Particular care will be given to insure that the earth sub-base and bedding next to the manhole will provide firm solid support to the pipe.
 7. Removal of Sewer Pipe:
 - a. Existing pipes and manholes to be removed and their locations will be shown on the Plans. Existing sewer pipe and manholes that must be removed to excavate for the proposed sewer will be included in the cost of the proposed sewer pipe and no additional compensation will be made to the Contractor. The City reserves the right to retain or reject salvage of any material encountered. All remaining material becomes the property of the Contractor who will 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 | Corps of Engineers | 40 (max) |
| U.S. Standard Sieve | CW-02215 | |

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 will be inspected on delivery. Pipe that does not conform to the requirements of these Specifications or is not suitable for use will be rejected and immediately removed from the work site.

B. Preparation of Pipe Ends

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

C. Care During Hoisting, Placing, And Pushing Home

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

D. Direction of Work

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

E. Uniform Pipe Bearing

1. Special care will be taken to insure that the pipe is solidly and uniformly bedded, cradled, or encased according to the Plans. For pipe with a bell that is larger than the barrel of the pipe the bedding material will be removed to a depth that will provide continuous support for the bell and barrel. No pipe will 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 will 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 will 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 will not be allowed except as directed by the Purchaser.
- G. Backfilling to Secure Pipe
1. When the joint is made, sufficient backfill material will be simultaneously placed along each side of the pipe to prevent moving the pipe off line and grade. Particular care will be used to prevent disturbance or damage to the pipe and the joints during backfilling.
- H. Flotation and Water in the Trench
1. The Contractor will take all necessary precautions to prevent flotation of the pipe in the trench. Water will not be allowed to rise in the trench. The Contractor will 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 Contractor will 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 Contractor.
- 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 will be protected from damage and a temporary tight fitting plug or bulkhead will 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 will 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 will be in a neat workmanlike manner at right angles to the pipe axis without damage to the pipe. Observe specifications regarding joint locations. Smooth the cut end by power grinding or filing to remove burrs and sharp edges. Repair lining of the pipe as required.
- L. Wyes and Special Fittings
1. Wyes, stubs, reducers, fittings, or other special pipes will be installed as shown on the Plans or where ordered by the Purchaser. The fittings and special pipes will be made of a compatible material, type, and class and/or strength designation as the pipe and installed as required by the Plans and Specifications. The cost for providing and installing the above items is incidental to the cost of the pipes.
- M. Valves
1. Valves and appurtenant fittings will be installed as shown on the Plans or where directed by the Purchaser.

2. Check valves and gate valves will be installed on either flanged or mechanical joint ductile iron pipe.
3. Air release, vacuum relief and combination air valves larger than 3 inches in diameter will be installed on either flanged or mechanical joint ductile iron pipe. A gate valve conforming to Specification Section 02530 2.01.Q shall be installed to isolate these air valves from the force main.
4. Air release, vacuum relief and combination air valves 3 inches in diameter and smaller will be installed on a ductile iron tap T fitting. A ball valve conforming to Specification Section 02530.Q shall be installed on a 6" threaded nipple between the 'T' and the air valve.

3.05 PIPE JOINTS

A. General

1. Pipe will be jointed immediately following the laying of each section. No pipe section will 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 will be thoroughly cleaned and a compression gasket compatible with the type of pipe to be joined will be at the position recommended by the pipe manufacturer.
2. Lubricant recommended by the gasket manufacturer will be liberally applied to the gasket and both ends immediately before pipe ends are joined. The upstream pipe will be positioned such that the spigot may enter the bell squarely. The pipe being laid will be pushed home and the gasket position checked with a feeler gauge before installation of the next section. Flat, unconfined gaskets on concrete pipe will be cemented to the spigot at the position recommended by the pipe manufacturer.

C. Mechanical Joints

1. The two ends to be joined will be thoroughly cleaned with a wire brush and the plain end, socket end, and gasket will be brushed with soapy water. The end will be centered in the socket and adequate anchorage will 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 will be made after joint assembly and before tightening bolts. Pipe deflection will 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 will be torqued to the required range recommended by the pipe manufacturer. Over stressing of bolts will be avoided. Gaskets on the spigot end will be checked following assembly to ensure proper positioning of bell and spigot has been accomplished.
3. Any joints not properly positioned will be disassembled, cleaned, and reassembled as previously indicated.

D. Flanged Joints

1. The two ends to be joined will be thoroughly cleaned with a wire brush. Bolt holes on each pipe flange to be joined will be aligned and bolts inserted. Bolts will be torqued evenly by alternating tightening of bolts opposite one another until all bolts are torqued to the recommended pressure.
- E. Restrained Joints
1. Restrained push-on joints are to be used as specified on the plans or by the Purchaser. These special joints will 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 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 will continue following as closely behind pipe installation as practical. All backfill will 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 will 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 will be responsible for the condition of the trenches and filled areas during the contract and warranty period. The Contractor will maintain frequent inspection of the same. Anytime during the 12-month warranty period the trenches or filled areas settle and sunken places appear, the Contractor will 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 will 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 and pipe trench excavations through pavements in street or highway right-of-way or where the Purchaser orders, will be made with pit run gravel or other acceptable material as approved by the Purchaser. The backfill will be from the top of the bedding material or 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 will be made with select earth from the top level of the bedding 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 will 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 will 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:

- 1) Backfill material will 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 will 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 will be mechanically placed in 9 inch, maximum, loose layers . All backfill material will 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:
 - 1) 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 will 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:
 - a. Backfill of excavations on unimproved property will be made with select material from the top level of bedding 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 , 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 will come in direct contact with the pipe. Stones and lumps will be kept separated and well distributed, and all voids will be completely filled with fine material.
 2. Placement of Backfill:
 - a. Backfill procedures specified in Specification Section 02530 Paragraph 3.11.B will 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. Removal of Excess Material
1. After the trench or excavation has been properly backfilled, all excess dirt will 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 Contractor will obtain written permission from the property owner for the spreading of excess soil, and a copy of the written permission will be submitted to the Engineer. Such spreading or filling will not obstruct surface drainage and be to the satisfaction of the property owner. Excess material will be disposed of by the Contractor.

3.07 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.

3.08 FINAL GRADING

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

3.09 CLEANING

- A. All necessary precautions will 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 will be cleaned of all dirt, jointing material and extraneous material. On small pipe where cleaning after laying may be difficult, a squeegee will be kept in the pipeline and pulled forward past each joint immediately after its completion. Before final inspection the Contractor will remove all debris and foreign material.

3.10 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.

3.11 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.

3.12 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.

3.13 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 LEAKAGE TESTS**

- A. The Contractor will perform hydrostatic pressure and leakage tests concurrently conforming to AWWA C 600, AWWA C 605, ASTM D 2774 or ASTM F 2164 procedures as applicable and as modified herein. Tests will apply to all sewage force mains after backfilling.
- B. Force mains will be tested separately in segments between sectionalizing valves, between a sectionalizing valve and a test plug, or between test plugs. Select test segments such that adjustable seated valves are isolated for individual checking. The Contractor will furnish and install test plugs at no additional cost, including all anchors, braces and other devices to withstand hydrostatic pressure on plugs. The Contractor will be responsible for any damage to public or private property caused by failure of plugs. Limit water fill rates of line to available venting capacity.
- C. Hydrostatic Pressure Test
 - 1. Conduct tests at 1.5 times maximum operating pressure determined by following
 - $P_{pr} = 0.650 (OP-GE)$, in which
 - P_{pt} = test pressure in psi at gauge elevation
 - OP = operating pressure in feet as indicated for highest elevation of the hydraulic gradient on each section of the line
 - GE = elevation in feet at center line of gauge
- D. Hydrostatic Leakage Test
 - 1. Conduct tests conforming to AWWA C 600, AWWA C 605, ASTM D 2774 or ASTM F 2164 procedures, as applicable, at maximum operating pressure determined by following formula:
 - $P_{11} = 0.433 (OP-GE)$, in which
 - P_{11} = test pressure in psi at gauge elevation
 - OP = operating pressure in feet as indicated for highest elevation of the hydraulic gradient on each section of the line
 - GE = elevation in feet at center line of gauge
- E. Satisfactorily complete previously defined pressure tests before determining the amount of leakage. Maximum allowable leakage will be determined by the following formula:
 - $$L = \frac{NDJP}{7400}$$
 - L = Allowable leakage in gallons/hour

N = Number of joints in length of pipeline tested

D = Nominal diameter of the pipe, in inches

P = Average test pressure during leakage test, in pounds per square inch, gauge

4.02 FINAL ACCEPTANCE

- A. When all work required by the Contract has been completed, the Contractor shall submit to the Engineer 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 plans. After receiving the surveyor's certification from the Contractor, the Engineer will make a final inspection of the Work, including any tests for operation. After completion of this inspection the Engineer will, if all things are satisfactory to him, issue to the Contractor 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 Contractor or his sureties from any guarantees under the Contract or the Performance Bond. Upon receipt of the Certificate of Completion the Contractor will clean the premises and see that they are in an orderly condition.

PART 5 - MEASUREMENT

5.01 SITE PREPARATION AND RESTORATION

- A. 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 Contractor under other contract items..

5.02 BYPASS TEE ASSEMBLY

- A. Bypass tee assembly shall be measured per each.

5.03 COMBINATION AIR VALVE ASSEMBLY

- A. Combination air valve assembly shall be measured per each.

5.04 VALVES

- A. Valves shall be measured per each.

5.05 BYPASS PUMPING

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

5.06 WET WELL PIPING REPLACEMENT

- A. Wet well piping replacement will be measured as a lump sum item.

5.07 DRY PIT PIPING REPLACEMENT

- A. Dry pit piping replacement will be measured as a lump sum item.

5.08 UNDERCUT BACKFILL

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

5.09 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 Contractor under other Pay Items of the Contract.

5.10 SEWAGE FORCE MAIN

- A. Sewage force main length will be measured per linear foot along the centerline of the pipe from the point of measurement at the pumping station or valve box shown on the Plans to the end of the force main at its discharge location. Shut-off and relief valves, valve boxes, and thrust blocks are incidental to the construction of the force main and/or pump station and will not be measured for payment.

5.11 TRAFFIC CONTROL

- A. No separate payment will be made for traffic control. All work pertaining to traffic control shall be considered obligations of the Subcontractor under other Pay Items of the Contract.

PART 6 - PAYMENT**6.01 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.

6.02 SEWAGE FORCE MAIN

- A. The accepted quantities of sewage force main will be paid for at the contract unit price per linear foot furnished and laid for the various sizes, types and classes or wall thicknesses, which will be full compensation for material and material testing, excavation, special protection, protection of existing utilities, bedding, laying, jointing, fittings, shut-off valves, relief valves, valve pits, thrust blocks, cleaning and inspection, conducting acceptance tests, connection to existing sewer manholes or structures, removal and/or abandonment of existing pipe within the limits of excavation and backfilling outside pavement areas.

6.03 BYPASS TEE ASSEMBLY

- A. Bypass tee assembly will be paid for at the contract unit price per each. This item will include but not be limited to all work and materials necessary to install the bypass tee assembly as shown on the plans including, but not limited to, all piping between and including the solid sleeves/couplings, fittings, valve, Bauer connection, precast concrete vault with drain line, crushed stone, excavation, and backfill.

6.04 COMBINATION AIR VALVE ASSEMBLY

- A. Combination air valve assembly will be paid for at the contract unit price per each. This item will include but not be limited to all work and materials necessary to install the combination air valve assembly as shown on the plans including, but not limited to, air valve, piping, fittings, ball valve, and service saddle.

6.05 VALVES

- A. Valves will be paid for at the contract unit price per each per type and size. This item will include but not be limited to all work and materials necessary to install the valve as shown on the plans.

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 WET WELL PIPING REPLACEMENT

- A. Wet well piping replacement will be paid at the appropriate contract lump sum price. This item includes all materials and labor necessary to replace the piping as shown on the plans including couplings, pipe and fittings, and sealing of existing pipe penetrations.

6.08 DRY PIT PIPING REPLACEMENT

- A. Dry pit piping replacement will be paid at the appropriate contract lump sum price. This item includes all materials and labor necessary to replace the suction and discharge piping in the dry pit, wall piping connections, including couplings, pipe and fittings, check valves, gate valves, and coating of dry pit.

6.09 PAYMENT WILL BE MADE UNDER

| ITEM NO. | PAY ITEM | PAY UNIT |
|---------------------------|----------------------------|-----------------|
| 360 NORTH HIGHLAND | | |
| 01-02530-6.01 | BYPASS TEE ASSEMBLY | EACH |
| 01-02530-6.02 | 8" GATE VALVE | EACH |
| 01-02530-6.03 | 8" CHECK VALVE | EACH |
| 01-02530-6.04 | 8" DUCTILE IRON PIPE | LF |
| 01-02530-6.05 | BYPASS PUMPING | LUMP SUM |
| 1217 MEADOWLARK | | |
| 02-02530-6.01 | BYPASS TEE ASSEMBLY | EACH |
| 02-02530-6.02 | 4" GATE VALVE | EACH |
| 02-02530-6.03 | 4" CHECK VALVE | EACH |
| 02-02530-6.04 | 4" X 6" REDUCER | EACH |
| 02-02530-6.05 | 4" DUCTILE IRON FORCE MAIN | LF |
| 02-02530-6.06 | BYPASS PUMPING | LUMP SUM |
| 4730 EAST SHORE | | |
| 03-02530-6.01 | BYPASS TEE ASSEMBLY | EACH |
| 03-02530-6.02 | 8" PLUG VALVE | EACH |
| 03-02530-6.03 | 8" CHECK VALVE | EACH |
| 03-02530-6.04 | 8" DUCTILE IRON FORCE MAIN | LF |
| 03-02530-6.05 | BYPASS PUMPING | LUMP SUM |
| 47 WEST VAN HUESEN | | |
| 04-02530-6.01 | BYPASS TEE ASSEMBLY | EACH |
| 04-02530-6.02 | 4" PLUG VALVE | EACH |
| 04-02530-6.03 | 4" CHECK VALVE | EACH |
| 04-02530-6.04 | 4" DUCTILE IRON FORCE MAIN | LF |
| 04-02530-6.05 | BYPASS PUMPING | LUMP SUM |

END OF SECTION

SECTION 02533
REHABILITATION AND REPAIR OF EXISTING MANHOLES AND WET WELLS PART 1

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. All specifications and provisions noted herein shall also apply to lift station concrete wet well rehabilitation and repair. 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 of the City of Memphis Standard Construction Specifications modified by the SARP10 Program.
- 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. of the City of Memphis Standard Construction Specifications modified by the SARP10 Program.
- 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 ft²) 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. 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 – 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 liner material over the surface of the replaced invert and bench where 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. Wet Well Rehabilitation –Coating
 - 1. Coating will be measured per vertical foot of wet well from the invert up to the bottom of the frame casting.
- B. Traffic Control
 - 1. Traffic control is considered to be an incidental to the wet well rehabilitation .
- C. Bypass Pumping
 - 1. Bypass pumping is considered to be an incidental to the wet well rehabilitation.
- D. Dewatering
 - 1. Dewatering is considered to be an incidental to the wet well rehabilitation.

4.02 PAYMENTS

- A. Wet Well Rehabilitation – Coating
 - 1. Coating of wet wells will be paid for at the contract unit price per vertical foot which shall be compensation for draining of wet well, surface preparation, sprayed on lining.

4.03 PAYMENT WILL BE MADE UNDER:

| Item No. | Pay Item | Pay Unit |
|--------------|------------------|----------|
| 02533-4.01.A | Wet Well Coating | VF |

END OF SECTION

**SECTION 02630
SITE PREPARATION AND RESTORATION**

PART 1 – SCOPE

1.01 SCOPE OF WORK

- 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 – EQUIPMENT

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 – CONSTRUCTION REQUIREMENTS

3.01 RIGHT-OF-WAY AND EASEMENT

- A. The Subcontractor shall confine his construction activities within the rights-of-way and/or easements per 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 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 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 Contractor 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 Contractor 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 Contractor 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 Contractor 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 Contractor 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 Owner. 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.

PART 4 – MEASUREMENT**4.01 SITE PREPARATION AND RESTORATION.**

- A. 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.
- B. 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.

END OF SECTION

**SECTION 02920
SEEDING**

PART 1 – GENERAL

1.01 SCOPE

- A. 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, % 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.
 1. Manufactured fertilizer shall be a standard commercial fertilizer containing the specified percentages by weight of nitrogen (N), phosphoric acid (P₂O₅) and potash (K₂O). 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.
 1. 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.
 1. 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.
 1. 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.
 1. Cut back asphalt, Grade RC-70 or RC-250 conforming to AASHTO Specifications shall be used.
 - G. Water.
 1. 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

- A. 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**

- A. 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.

- A. 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.

- A. 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.

- A. 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 1½ 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 nontillable.

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 to 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.

- A. 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.

- A. 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

4.01 FURNISHING THE SEED

- A. 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.

4.02 SEEDING (WITH MULCH)

- A. The area of seeding (with mulch) to be measured 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.

4.03 SEEDING (WITHOUT MULCH)

- A. 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.

4.04 BIODEGRADABLE FABRIC

- A. 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.

4.05 GENERAL

- A. 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)**

- A. 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)

- A. 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

- A. 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

**SECTION 11310
DRY PIT SUBMERSIBLE PUMPS, VALVES, CONTROLS, & ACCESSORIES**

PART 1 - GENERAL

1.01 SCOPE

- A. This section includes equipment for one duplex submersible pump station to be supplied with integral electric motors, suction elbows, pump stand 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

PART 2 – QUALITY ASSURANCE

2.01 GENERAL

- A. A. 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

- A. A. 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

- A. All equipment as specified herein shall be so supplied with respect to environmental conditions at the jobsite.

2.04 SUBMITTALS

- A. 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.
1. Data and specifications for the equipment shall include, but shall not be limited to the following:
- B. 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.
- C. 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.
- D. 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.

PART 3 - TESTING

3.01 SHOP TESTS

- A. 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.

- B. 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

- A. Acceptance tests shall be run to demonstrate that the pumping units, motors and control system meet the following requirements:
- B. The pumping units operate as specified without excessive noise, cavitation, vibration, and without overheating of the bearings.
- C. All automatic and manual controls function in accordance with the specified requirements.
- D. All drive equipment operates without being overloaded.

PART 4 - PERFORMANCE

4.01 SUBMERSIBLE PUMPS

- A. Submersible Pumps shall meet the following performance requirements:

| Item (Units) | 4730 East Shore | 1217 Meadowlark |
|---|---------------------------------|---------------------------------|
| Primary Duty Point (GPM/ft.) | 595 GPM@ 71' TDH | 306 GPM@ 34' TDH |
| Secondary Duty Point (GPM/ft.) Less than 60 Hz | 1000 GPM@ 38' TDH | 237 GPM@ 21' TDH |
| Minimum Shutoff Head (ft.) | 124 Ft. | 124 Ft. |
| Maximum Specific Energy at Primary Duty Point (KWHr/MG) | 359 KWHr/MG | 190 KWHr/MG |
| Max Motor Rating (HP) at 40 degrees C | 20 HP @ 40° C | 5 HP @ 40° C |
| Maximum NPSHre (ft) in Operation Range | 14 Feet | 15 Feet |
| Voltage/Cycle/Phase | 230VAC/60Hz/ 3Phase | 240VAC/60Hz/ 3Phase |
| Motor Design Type | NEMA Class B, NEMA MG1, Part 31 | NEMA Class B, NEMA MG1, Part 31 |
| Motor Service Factor | Greater than 1.15 | Greater than 1.15 |
| Minimum Motor Efficiency | 87% | 85% |
| Motor Insulation Rating | Class H | Class H |
| Maximum Rated Current (A) | 52 Amps | 12 Amps |
| Pump Suction x Discharge Size (inches) | 6" x 4" | 4" x 4" |

PART 5 - PUMPING EQUIPMENT**5.01 PUMP DESIGN (DRY PIT SUBMERSIBLE)**

- A. The pumps shall be capable of handling raw, unscreened sewage. Pumps shall be supplied with a mating suction elbow and pump stand and be capable of delivering the flow specified in the table above. The pumps shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The pump and motor shall be non-overloading at any point on the curve. The pump, with its appurtenances and cable, shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of sixty five (65) feet. No portion of the pump shall bear directly on the sump floor

5.02 PUMP CONSTRUCTION

- A. Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass shall be protected by a factory applied spray coating. 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. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton Rubber O-rings. Joint sealing 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 bolt torque limit. Rectangular cross-sectioned gaskets that require 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 in any part of the pump.

5.03 CABLE & CABLE SEAL

- A. The cable entry shall be threaded and sealed by a field replaceable dual grommet system. A nylon clamp shall secure a strain relief function. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.
- B. The motor shall be equipped with 50 feet of shielded submersible cable. The shield within the cable shall allow for a control panel mounted interface component to communicate both ways with the integrally mounted control unit within the pump/motor housing. 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 chlorinated polyethylene rubber. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

5.04 COOLING SYSTEM

- A. Each unit shall be provided with an adequately designed cooling system that allows up to 10 motor starts per hour on a continuous basis and the ability to pump liquids of up to 104oF with no damage to motor windings, bearings, or drive shaft seals.
- B. The motor shall be provided with an integral motor cooling system. A motor cooling jacket shall encircle the stator housing, providing for dissipation of motor heat regardless of the type of pump installation. An impeller, integral to the cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid through the jacket. The cooling liquid shall pass about the stator housing in the closed loop system in turbulent flow providing for superior heat transfer. The cooling system shall have one fill port and one drain port integral to the cooling jacket. The cooling system shall provide for continuous pump operation in liquid or ambient temperatures of up to 104°F. (40°C.). Operational restrictions at temperatures below 104°F are not acceptable. Fans, blowers or auxiliary cooling systems that are mounted external to the pump motor are not acceptable.

5.05 MECHANICAL SEAL

- A. 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 contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. 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.
- B. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant expansion. The seal lubricant chamber shall have one drain and one inspection plug that are accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for lubrication

5.06 SHAFT

- A. The pump and motor shaft shall be the same unit. The pump shaft shall be an extension of the motor shaft. Couplings shall not be acceptable. The shaft shall be AISI Type 431 stainless steel and shall be completely isolated from the pumped liquid. The use of Stainless steel sleeves shall not be considered equal to stainless steel shafts.

5.07 IMPELLER AND VOLUTE

- A. The impeller shall be of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.
- B. 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 of 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.

5.08 BEARINGS

- A. The integral pump/motor 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 ball type bearing to handle radial loads. The lower bearing shall be a two row angular contact ball bearing to handle the thrust and radial forces. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump curve.

5.09 MOTOR & PROTECTION DEVICES

- A. The integrated control system shall continuously monitor the leakage sensor in the stator housing and the temperature of the motor. If the motor temperature is too high, the pump shall be capable of operating at a reduced speed until the high temperature conditions are normalized. 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. External trips or overload devices for motor protection shall not be required.

PART 6 – CONTROL PANEL

6.01 SCOPE

- A. The System Supplier shall provide a Duplex Pump Control system that shall control connected pumps in an energy conservation mode of operation. The system shall be capable of adapting to changing inflow conditions and shall automatically regulate pumped outflow based on inflow conditions and shall seek an optimal energy efficiency for the pump station. This shall be accomplished by either providing a Programmable Logic Controller (PLC) with Variable Frequency Drives (VFDs) to provide a station adaptable feature or Variable Frequency Drive with integral software designed for this purpose. Either supplied system shall be MONITORING SYSTEM ready for integration into the City of Memphis MONITORING SYSTEM system, if applicable. MONITORING SYSTEM ready specification means that the units are capable of MODBUS communication. Radios, cellular modems, antennas etc. are not included in this control panel. This system will incorporate the functionality as noted in the following sections.

6.02 ELECTRICAL CONTROL PANEL SPECIFICATIONS

- A. The System Supplier shall furnish a NEMA 3R Painted (white) steel control panel enclosure that will house the equipment furnished as specified herein to provide integral liquid level control, moisture and thermal protection modules with either a PLC and VFD's or Advanced Integrated VFD. The enclosure shall be a definite purpose enclosure to maximize cooling of the installed equipment and will be provided with a minimum of the following:
1. Main Lugs for Incoming Power. The Control Panel shall incorporate Feeder Breakers of the appropriate size. The breakers shall be Heavy Duty NEMA rated and suitable for use with aluminum or copper conductors. Utility Meter and Fused Disconnect shall be located outside of the panel and be provided by an Electrical Contractor or shall be existing where applicable.
 2. Each pump motor circuit shall be protected by a properly sized H frame molded case circuit breaker. Each pole of these breakers shall provide inverse time delay overload protection and instantaneous short circuit protection by means of a thermal magnetic element. The breaker shall be operated by a toggle type handle and shall have a Quick-make, Quick-break over center switching mechanism that is mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping due to overload or short circuit shall be clearly indicated by the handle automatically assuming a position midway between the manual "ON" and "OFF" position. The minimum interrupting rating of the breaker shall be 42,000 amps at 460 VAC. Pump motor circuit breaker toggle shall be operable through a cutout in the inner door.
 3. Hand-Off-Automatic (external or integral to the VFD HMI) switches to select the operating mode for each pump installed on the control panel inner deadfront door.
 4. Elapsed time meters and Run, Fail and Alarm Lights shall be provided for each pump motor with appropriate relays as required.
 5. In the event either pump operation selector switch is in the "Off" position, the control system software shall automatically designate the operating pump motor as the "next pump motor to operate" after that pump motor is started.

6. The hinged inner door shall be provided and fabricated from, 5052-H32.080, marine alloy aluminum. The hinged inner door shall contain cutouts for all circuit breaker toggles. Control switches and indicators shall be labeled and mounted to the hinged inner door to keep operators from entering the live electrical compartment. A warning sign stating "DANGER -- Disconnect All Sources Of Power Before Opening Door" shall be installed on the inner door. The inner door shall be completely removable for ease of service and shall be held closed by at least (2) hand operated 1/4 turn fasteners. The following items shall be mounted on the inner door:
 7. Hand-Off-Automatic – External or Integral to the VFD Operator Interface
 8. Back-panel - The control system enclosure shall include a removable back-panel. The back-panel shall be painted white and fabricated from cold roll steel.
 9. Components shall be fastened to the back-panel using stainless steel pinhead machine screws. All devices shall be clearly labeled in accordance with the schematic ladder diagram.
 10. Transient Voltage Surge Suppressors on the 120VAC circuit
 11. Loop Power Surge Suppressor
 12. Dual Signal Splitters 9106 for a total of 3 Analog Outputs
 13. Lightning Arrestor
 14. Cooling Fan and Enclosure Light
 15. Top Mounted Alarm Light
- B. Energy Management Components furnished by the System Supplier
 1. A Variable Frequency Drive with integral wastewater algorithms or a PLC with Variable Frequency Drive shall be provided for each pump in the system, sized for the appropriate voltage and power. The units(s) shall be supplied by the System Supplier and designed for wastewater pumping and with functionality pre-programmed for the specific pump model used. The VFD with Integral Control or PLC with VFD shall provide all level control functionality, hand/auto operation, pump alternation, pump over temperature monitoring, seal leakage monitoring, pump self-cleaning, sump cleaning and pipe cleaning algorithms. The supplied system shall also include capability to monitor station inflow, pump speed and energy consumption in order to automatically operate the pump station at optimal energy efficiency.
 2. The system shall be tested and approved in accordance with national and international standards and comply with Directive 98/37/EC, Safety of Machinery and EN60204-1.
 3. It shall conform to the relevant safety provisions of the Low Voltage Directive 2006/95/EC and the EMC Directive 2004/108/EC and has been designed and manufactured in accordance with the following harmonized European standards:

| | |
|-------------------------|--|
| EN 61800-5-1: 2003 | Adjustable speed electrical power drive systems. Safety requirements. Electrical, thermal and energy. |
| EN 61800-3 2nd Ed: 2004 | Adjustable speed electrical power drive systems. EMC requirements and specific test methods |
| EN 55011: 2007 | Limits and Methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment (EMC) |
| EN60529 : 1992 | Specifications for degrees of protection provided by enclosures |

The variable frequency drive ampere rating shall be equal to or greater than the ampere rating listed on the motor being driven by the variable frequency drive.

4. The drive units shall be modularly constructed. Printed circuit boards shall be connected in such manner that they are easily removed from the unit. Power components shall be readily accessible and be connected in such manner that they are easily removed from the unit. The pump drive shall be freestanding for wall mounting or cabinet installation construction, for 230-480V, 60HZ 3Phase supply and shall be rated for IP55 and IP66 isolation class.
- C. System Operation – VFD with Integral Control or PLC and VFD Functionality
1. High/Low Level Sump Control:
 - a. The system shall provide automatic level control via means of a submersible pressure transducer (4-20mADC) and one (1) non-mercury liquid level float switch. A user-programmable Start Level shall indicate the point at which the pump will start. Upon activation the pump shall run at maximum speed for a pre-determined period, then ramp down to an energy efficient optimal speed, calculated by the system. When the water level reaches the Stop Level, the pump shall stop. The Optimal Speed shall either be calculated by the system or manually entered by the user.
 - b. In case of high inflow, the system shall increase pump speed until the water level begins to decrease. When the water level reaches the Stop Level, the pump shall stop.
 - c. In case of very high inflow, when a pump or pumps are unable to overcome the inflow conditions even at maximum speed, additional pumps shall be activated and run at maximum speed until the stop Level is reached. If water levels continue to rise, a High Level Alarm shall be activated.
 - d. The system shall incorporate a Minimum Speed function that prevents the pump from operating at speeds too low to move water based on the pump curve.
 2. Run Time Averaging:
 - a. The system shall provide capability to balance run times for even wear among available operable pumps. This shall be a function of the control system and not require external devices, such as an Alternating Relay. The function shall operate by determining a “random” start level based on the Start Level setting. The system shall determine a random start level independent of each other. The system shall determine new random start levels every 24 hours. The pump with the lowest random start level shall be first to start on any given pump cycle. Other pumps shall remain in Standby capacity in case the lead and/or lag pump shall not be able to lower the water level as described in the section above. By recalculating the random start levels every 24 hours, balanced run times are accomplished.
 3. Pump Cleaning Function:
 - a. The system shall incorporate a “self-cleaning” function to remove debris from the pumps. The cleaning shall be triggered by three circumstances:
 - 1) Soft Clogging: When motor current equals 20% or greater above rated motor current , in the drive, for a period of 7 seconds
 - 2) Hard Clogging: When motor current equals 80% or greater above rated current for a period of 0.01 seconds
 - 3) Schedule Cleaning: The system is pre-programmed to perform cleaning regularly
 - 4) 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, drive shall resume to automatic operation.
 4. Sump Cleaning Function:
 - a. The system shall incorporate a sump cleaning function to ensure surface solids and grease is regularly removed from the sump. The sump cleaning function shall perform regularly when enabled by the operator. Sump cleaning shall consist of the following functions

- 1) Sump cleaning is triggered when internal timer expires and during a normal pump down cycle
 - 2) Pump is automatically ramped to maximum speed
 - 3) Pump runs at maximum speed for designated time or until the pump are snoring."
 - 4) When Sump Cleaning is over, the pump is shut off and resumes normal operation.
5. Pipe Cleaning Function:
- a. The system shall incorporate a pipe cleaning function to avoid discharge pipe sedimentation and clogging due to reduced pump speed. This shall be an automatic feature that initiates with every pump cycle. Upon reaching Pump Start Level, the system shall operate the pump at 100% speed for a determined time before ramping down to the most energy efficient speed for the duration of the cycle.
6. Energy Efficiency Speed Finder:
- a. The system shall provide a function that automatically calculates the most energy efficient speed for the pump based on station inflow characteristics. An algorithm calculates the optimal speed whereby the most water is pumped using the least amount of energy, the optimal speed is constantly adjusted to account for changes inflow without requiring operator adjustment, multiple setpoints, etc.
 - b. The energy efficient function prevents the drive from running off of the system curve for the pump. This will ensure maximum hydraulic efficiency as well as electrical efficiency is maintained.
7. Alarms & Monitoring:
- a. The system shall provide alarms and monitoring for the system, pump and sump. Alarms shall be presented on the display, via a Summary Alarm relay and via Modbus registers. All alarms, when occurring, shall remain active until reset. Alarms shall have a built-in 4 second delay to prevent nuisance tripping. Alarms shall be as follows:
 - 1) Pump Monitoring:
 - (a) Pump Over Temperature (thermal contacts in motor stator)
 - (b) Pump Seal Leak (Seal leakage sensor)
 - 2) Sump Monitoring:
 - (a) High Sump Level (via level float switch or submersible transducer)
 - (b) Submersible transducer Sensor Error (Submersible transducer is not connected, reports faulty values or the wrong start level is used)
 - 3) Pump drive Monitoring (includes, but not limited to):
 - (a) Drive Overcurrent
 - (b) Drive Overload Trip
 - (c) Drive Overvoltage
 - (d) Drive Undervoltage
 - (e) Drive Overtemperature (internal)
 - (f) Drive Overtemperature (ambient)
 - (g) Drive Undertemperature (ambient)
 - (h) Input Phase Loss
 - (i) Drive Output Max Torque Exceeded
- D. Submersible Pressure 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. The unit shall be set to operate at 16.4 Feet for this application.

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. The design without sharp edges prevents particles, textiles and paper from sticking to the housing or the diaphragm. The transducer shall be surge resistant.
8. The transducer power cable shall be steel reinforced PUR cable with high tensile strength (2,000 lb).

PART 7 – PUMP STATION VALVES

7.01 PUMP STATION VALVES

- A. The system supplier shall furnish 2 check valves, 2 knife gate valves and the number of air vacuum/air release valves as shown on the plans. These items shall be shipped loose for installation in the pump station valve vault and along the force main as required. Piping, fittings, bolts, gaskets in the valve vault and along the force main shall be supplied by the contractor.

7.02 PUMP STATION VALVES – SUPPLY AS SHOWN ON THE PLANS

- A. Plug valves shall be of the non-lubricating, eccentric type and shall be designed for a working pressure of 175 psi for valves 12” and smaller, 150 psi for valves 14” and larger. Valves shall provide tight shut-off at rated pressure. Valve shall be manufactured by Henry Pratt. Valves 20” and smaller shall have round port design. Minimum port area for all valves shall be 80% of corresponding pipe area.
- B. The plug valve body shall be cast iron ASTM A126 Class B with welded-in overlay of 90% nickel alloy content on all surfaces contacting the face of the plug. Sprayed, plated, nickel welded rings or seats screwed into the body are not acceptable. The valve plug shall be cast iron ASTM A126 Class B, with Buna N resilient seating surface to mate with the body seat. Valve flanges shall be in strict accordance with ANSI B16.1, Class 125.
- C. Plug valve shall be furnished with permanently lubricated sleeve type bearings conforming to AWWA C504. Bearings shall be of sintered, oil impregnated type 316 stainless steel ASTM A-743 Grade CF-8M or bronze ASTM B-127. Valves shaft seals shall be of the “U” cup type, in accordance with AWWA C504. Seals shall be self adjusting and repackable without moving the bonnet from the valve. 6” and smaller exposed valves shall be provided with wrench actuators. 8” and larger exposed valves shall be provided with worm gear type manual actuators. All buried valves shall be provided with worm and gear actuators suited for the intended service.

- D. Swing check valves are of self-contained free swinging disc style. Valves conform to all standards set forth in AWWA C508. Valve hinge pins are Stainless Steel and conform to the industry standards set forth for cushion valves. Manufacturer should have a minimum of ten years experience supplying AWWA C508 valves. Valves shall conform to ANSI B16.1: Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800 and AWWA C508: Swing Check Valves for Waterworks Service, 2" through 24" NPS. Valves are rated for 200 p.s.i. water working pressure. All testing is done in accordance with AWWA C508. Valves have integrally cast flat face flanges in accordance with ANSI B16.1 Class 125. All cast iron used conforms to ASTM A126 CLB. Valve Hanger and Disc are of cast iron conforming to ASTM A126 CLB. Hinge Pins conform to ASTM A276 GR304. Seat Rings are of Low Zinc Bronze conforming to ASTM B62 or of Stainless Steel conforming to ASTM A276 GR316. Internal and external coatings are high build two component epoxy conforming to AWWA C550. All valves meet the standards of AWWA C508. All valves utilize a single disc mounted to a clevis hinge which prevents the disc from tipping. The valve disc swings open once the pump starts and allows for full flow. When closed the valve offers a tight shut-off. Valve body and cover are of Cast Iron, valve hinge is of Cast Iron. Disc seating surface is either Bronze, Stainless Steel or of Buna-n depending on application. Valve seat rings are of Bronze or Stainless Steel. The valve body has a bolted cover design and flanges are integral to body casting –not wafer style. Valve body and disc are designed in such a way as to minimize turbulence. Spring systems are externally mounted on the side of the body and do not come into contact with main line media. Markings on the valves are in accordance with AWWA C508, and include the name of manufacturer, the year of manufacture, maximum working pressure and size of valve. All valves are built for horizontal installation. However, all valves operate equally well in the vertical installations.
- E. Knife Gate Valves shall be of the Bonneted type, rated for 150 PSI CWP. Flanges shall be drilled and tapped to ANSI B16.5, Class 150 pound standard with raised faces. Flange raised face shall be machined using serrated-spiral or serrated-concentric grooves with a 125-250 RMS finish. Valve bodies shall be cast CF8 or CF8M stainless steel (304ss). The valve bonnet shall be fabricated with 304 stainless steel liner, packing box and bonnet flange raised face. Bonnet flange and stiffeners shall be 304 stainless steel. A gate wiper shall be used between the bonnet flange and the body top flanges. The wiper material shall be UHMWPE. Valve shall have 304 gate and integral cast stainless steel seat in the valve body. Gate shall be of design and thickness to withstand full 150 PSI rated pressure without permanent deflection to the gate. Gate shall have a rounded, beveled bottom. Seat and gate shall have a fully machined finish for one way shutoff. Minimum of two gate wedges shall be provided to assist seating of the gate against the seat in the lower half of the valve body. Gate guides shall be provided in the upper half of the valve body. Packing gland shall be cast stainless steel (CF8/CF8M). Packing shall be Teflon lubricated synthetic packing with a minimum of 4 rows of packing. Packing gland bolts, studs and nuts shall be 304 Stainless steel. Valve yoke shall be cast CF8 (304) stainless steel. Yoke shall be the flat top design to allow bolt-on field installation or conversion of actuators without welding or machining. Valve stem shall be 304 stainless steel (same material grade as bonnet liner) with full ACME threads. Stem nut shall be bronze. Stem nut shall be enclosed by the use of a cast stainless steel retainer. Manually actuated valves shall be hand wheel operated for all sizes. Bevel gear operators are recommended for valves 16" and above where frequent operation is required and/or where used in applications above 75 PSI. Valves shall be designed, manufactured and tested to MSS SP-81 standard or AWWA C520 standard.
- F. Air and Vacuum Valves, where required, shall have the following functions: continuous discharge of dis-entrained pressurized air/gas, unrestricted vacuum break, and pipeline surge protection in a single chamber. Valves shall be anti-surge and anti-shock air release and vacuum break valves. The small orifice shall release air accumulations after the pipeline is filled, under pressure and in operation. The valve shall be equipped with an integral surge alleviation mechanism that automatically dampens surge pressures due to rapid air discharge or the subsequent rejoining of separated water columns. The valves shall be designed with the following features and materials of construction:

1. The intake/discharge orifice area is equal to the nominal size of the valve, i.e., an 8" valve shall have 8" full flow inlet and 8" outlet.
2. Nozzle and Anti-Shock floats shall be solid unbreakable HDPE that will not deform under twice the design working pressure.
3. Manufacturer shall have ISO 9001, and third party vacuum testing to certify sizing and performance. CFD, FEA or other types of theoretical modeling are not acceptable.
4. Valve shall have a 10 year in-service warranty for all internal components.
5. 304 Stainless Steel Body, Flange, Top Cover and Fasteners
6. 316 Stainless Steel Nozzle & Lower Float Assembly
7. Integral High Density Polyethylene Anti-Shock and Nozzle Floats
8. EPDM Seats and Seals
9. Tangential top and bottom Flushing Ports.

PART 8 - EXECUTION

8.01 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.

8.02 PREPARATION

- A. Make corrections and/or repairs as required for items inspected and found to be deficient.

8.03 INSTALLATION

- A. Install pumps and accessories in strict accordance with the manufacturer's instructions.

8.04 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.

8.05 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.

8.06 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 9 - SERVICE AND WARRANTY

9.01 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.

9.02 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 24 - 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

**SECTION 11311
DRY PIT SUBMERSIBLE PUMPS, VALVES, CONTROLS, & ACCESSORIES**

PART 1 - GENERAL DESCRIPTION

1.01 SCOPE

- A. This section includes equipment for one duplex submersible pump station to be supplied with integral electric motors, suction elbows, pump stand 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

PART 2 - QUALITY ASSURANCE

2.01 GENERAL

- A. 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

- A. 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

- A. 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.

PART 3 - TESTING

3.01 SHOP TESTS

- A. 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.
- B. 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.

PART 4 – PERFORMANCE

4.01 SUBMERSIBLE PUMPS

Submersible pumps shall meet the following performance requirements:

| Item (Units) | 360 North Highland | 47 West Van Heusen |
|---|---------------------------------|---------------------------------|
| Primary Duty Point (GPM/ft.) | 515 GPM@ 36' TDH | 100 GPM@ 46' TDH |
| Secondary Duty Point (GPM/ft.) Less than 60 Hz | 800 GPM@ 25' TDH | 200 GPM@ 30'TDH |
| Minimum Shutoff Head (ft.) | 60 Ft. | 54 Ft. |
| Maximum Specific Energy at Primary Duty Point (KWHr/MG) | 190 KWHr/MG | 360 KWHr/MG |
| Max Motor Rating (HP) at 40 degrees C | 7.5 HP @ 40° C | 6.4 HP @ 40° C |
| Maximum NPSHre (ft) in Operation Range | 14 Feet | 5 Feet |
| Voltage/Cycle/Phase | 230VAC/60Hz/ 3Phase | 230VAC/60Hz/ 3Phase |
| Motor Design Type | NEMA Class B, NEMA MG1, Part 31 | NEMA Class B, NEMA MG1, Part 31 |
| Motor Service Factor | Greater than 1.15 | Greater than 1.15 |
| Minimum Motor Efficiency | 85% | 87% |
| Motor Insulation Rating | Class H | Class H |
| Maximum Rated Current (A) | 21 Amps | 17 Amps |
| Pump Suction x Discharge Size (inches) | 6" x 4" | 4" x 3" |

PART 5 - PUMPING EQUIPMENT

5.01 PUMP DESIGN (DRY PIT SUBMERSIBLE)

- A. The pumps shall be capable of handling raw, unscreened sewage. Pumps shall be supplied with a mating suction elbow and pump stand and be capable of delivering the flow specified in the table above. The pumps shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The pump and motor shall be non-overloading at any point on the curve. The pump, with its appurtenances and cable, shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of sixty five (65) feet. No portion of the pump shall bear directly on the sump floor

5.02 PUMP CONSTRUCTION

- A. Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities. Higher density cast irons (Class 40 and above) with reduced vibration dampening, will not be acceptable for pump driver castings, such as stator and bearing housings. All exposed nuts or bolts shall be AISI type 316 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel and/or brass, shall be protected by a factory-applied coating system suitable for sewerage pumping applications.
- B. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton Rubber O-rings. Joint sealing 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 bolt torque limit.
- C. Rectangular cross-sectioned gaskets that require 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 in any part of the pump.

5.03 CABLE & CABLE SEAL

- A. The cable entry shall be threaded and sealed by a field replaceable grommet. A nylon clamp shall secure a strain relief function. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.
- B. The motor shall be equipped with 50 feet of shielded submersible cable. The shield within the cable shall allow for a control panel mounted interface component to communicate both ways with the integrally mounted control unit within the pump/motor housing. 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 chlorinated polyethylene rubber. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

5.04 COOLING SYSTEM

- A. The cooling system shall provide sufficient cooling to run the pump at continuous pump duty in an ambient temperature of up to 104°F. Operational restrictions at temperatures below 104°F or the demand of auxiliary cooling systems like fans or blowers are not acceptable.
- B. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant expansion. The seal lubricant chamber shall have one drain and one inspection plug that are accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for lubrication. The cooling system shall be a radiant heat sink type system integral to the stator housing.

5.05 MECHANICAL SEAL

- A. Each pump shall be provided with dual tandem mechanical shaft seal system comprising two totally independent seal assemblies. The seals shall operate in a seal lubricant buffer chamber that hydro-dynamically lubricates the lapped seal faces at a constant rate. The inner seal, located between the lubricant buffer chamber and the stator housing, shall contain one stationary and one positively driven rotating ring, functioning as an independent secondary barrier between the pumped liquid and the stator housing. Both inner seal faces shall be corrosion resistant Tungsten Carbide. The outer of the tandem set of seals function as the primary barrier between the pumped liquid and the stator housing. This set shall consist of a stationary ring and a positively driven rotating ring, both of which shall be corrosion resistant.

- B. Each interface shall be held in contact by its own spring system supplemented by external liquid pressures. The seals shall require neither maintenance nor adjustment, but shall be easily inspected and replaceable. The lower (outer) seal shall not bear on the impeller and shall remain fixed upon impeller removal.
- C. Shaft seals without positively driven rotating members, or conventional double mechanical seals with a common single or double spring acting between the upper and lower units requiring a substantial pressure differential to offset external pressure and effect sealing, shall not be considered acceptable nor equal to the dual independent seal system specified. Cartridge-type seals comprising a single rotating element sandwiched between dual stationary elements will not be considered a dual tandem seal system and will not be accepted. Seals shall not be of the uni-directional type, but capable of dual rotation with no damage. The shaft sealing system shall be capable of withstanding volute pressures up to 1.5 times pump shutoff head. No seal damage shall result from operating the pumping unit in its liquid environment, from running pump dry, or from reverse pump operation. The drain and inspection plug, with positive anti-leak seal, shall be easily accessible from the outside.

5.06 SHAFT

- A. The pump and motor shaft shall be the same unit. The pump shaft shall be an extension of the motor shaft. Couplings shall not be acceptable. The shaft shall be AISI Type 431 stainless steel and shall be completely isolated from the pumped liquid. The use of Stainless steel sleeves shall not be considered equal to stainless steel shafts.

5.07 IMPELLER AND VOLUTE

- A. The impeller shall be of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall move axially upwards on its shaft to allow larger debris to pass through and immediately return to normal operating position. The impeller shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.
- B. 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 of 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.

5.08 BEARINGS

- A. The integral pump/motor 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 ball type bearing to handle radial loads. The lower bearing shall be a two row angular contact ball bearing to handle the thrust and radial forces. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump curve.

5.09 MOTOR & PROTECTION DEVICES

- A. The integrated control system shall continuously monitor the leakage sensor in the stator housing and the temperature of the motor. If the motor temperature is too high, the pump shall be capable of operating at a reduced speed until the high temperature conditions are normalized. 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. External trips or overload devices for motor protection shall not be required.

PART 6 – CONTROL PANEL

6.01 SCOPE

- A. The System Supplier shall provide a Duplex Pump Control system that shall control connected pumps in an energy conservation mode of operation. The system shall be capable of adapting to changing inflow conditions and shall automatically regulate pumped outflow based on inflow conditions and shall seek an optimal energy efficiency for the pump station. This shall be accomplished by either providing a Programmable Logic Controller (PLC) with Variable Frequency Drives (VFDs) to provide a station adaptable feature or Variable Frequency Drive with integral software designed for this purpose. Either supplied system shall be MONITORING SYSTEM ready for integration into the City of Memphis MONITORING SYSTEM system, if applicable. MONITORING SYSTEM ready specification means that the units are capable of MODBUS communication. Radios, cellular modems, antennas etc. are not included in this control panel. This system will incorporate the functionality as noted in the following sections.

6.02 ELECTRICAL CONTROL PANEL SPECIFICATIONS

- A. The System Supplier shall furnish a NEMA 3R Painted (white) steel control panel enclosure that will house the equipment furnished as specified herein to provide integral liquid level control, moisture and thermal protection modules with either a PLC and VFD's or Advanced Integrated VFD. The enclosure shall be a definite purpose enclosure to maximize cooling of the installed equipment and will be provided with a minimum of the following:
1. Main Lugs for Incoming Power. The Control Panel shall incorporate Feeder Breakers of the appropriate size. The breakers shall be Heavy Duty NEMA rated and suitable for use with aluminum or copper conductors. Utility Meter and Fused Disconnect shall be located outside of the panel and be provided by an Electrical Contractor or shall be existing where applicable.
 2. Each pump motor circuit shall be protected by a properly sized H frame molded case circuit breaker. Each pole of these breakers shall provide inverse time delay overload protection and instantaneous short circuit protection by means of a thermal magnetic element. The breaker shall be operated by a toggle type handle and shall have a Quick-make, Quick-break over center switching mechanism that is mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping due to overload or short circuit shall be clearly indicated by the handle automatically assuming a position midway between the manual "ON" and "OFF" position. The minimum interrupting rating of the breaker shall be 42,000 amps at 460 VAC. Pump motor circuit breaker toggle shall be operable through a cutout in the inner door.
 3. Hand-Off-Automatic (external or integral to the VFD HMI) switches to select the operating mode for each pump installed on the control panel inner deadfront door.
 4. Elapsed time meters and Run, Fail and Alarm Lights shall be provided for each pump motor with appropriate relays as required.
 5. In the event either pump operation selector switch is in the "Off" position, the control system software shall automatically designate the operating pump motor as the "next pump motor to operate" after that pump motor is started.

6. The hinged inner door shall be provided and fabricated from, 5052-H32.080, marine alloy aluminum. The hinged inner door shall contain cutouts for all circuit breaker toggles. Control switches and indicators shall be labeled and mounted to the hinged inner door to keep operators from entering the live electrical compartment. A warning sign stating "DANGER -- Disconnect All Sources Of Power Before Opening Door" shall be installed on the inner door. The inner door shall be completely removable for ease of service and shall be held closed by at least (2) hand operated 1/4 turn fasteners. The following items shall be mounted on the inner door:
 7. Hand-Off-Automatic – External or Integral to the VFD Operator Interface
 8. Back-panel - The control system enclosure shall include a removable back-panel. The back-panel shall be painted white and fabricated from cold roll steel.
 9. Components shall be fastened to the back-panel using stainless steel pinhead machine screws. All devices shall be clearly labeled in accordance with the schematic ladder diagram.
 10. Transient Voltage Surge Suppressors on the 120VAC circuit
 11. Loop Power Surge Suppressor
 12. Dual Signal Splitters 9106 for a total of 3 Analog Outputs
 13. Lightning Arrestor
 14. Cooling Fan and Enclosure Light
 15. Top Mounted Alarm Light
- B. Energy Management Components furnished by the System Supplier
 1. A Variable Frequency Drive with integral wastewater algorithms or a PLC with Variable Frequency Drive shall be provided for each pump in the system, sized for the appropriate voltage and power. The units(s) shall be supplied by the System Supplier and designed for wastewater pumping and with functionality pre-programmed for the specific pump model used. The VFD with Integral Control or PLC with VFD shall provide all level control functionality, hand/auto operation, pump alternation, pump over temperature monitoring, seal leakage monitoring, pump self-cleaning, sump cleaning and pipe cleaning algorithms. The supplied system shall also include capability to monitor station inflow, pump speed and energy consumption in order to automatically operate the pump station at optimal energy efficiency.
 - a. The system shall be tested and approved in accordance with national and international standards and comply with Directive 98/37/EC, Safety of Machinery and EN60204-1.
 - b. It shall conform to the relevant safety provisions of the Low Voltage Directive 2006/95/EC and the EMC Directive 2004/108/EC and has been designed and manufactured in accordance with the following harmonized European standards:

| | |
|-------------------------|--|
| EN 61800-5-1: 2003 | Adjustable speed electrical power drive systems. Safety requirements. Electrical, thermal and energy. |
| EN 61800-3 2nd Ed: 2004 | Adjustable speed electrical power drive systems. EMC requirements and specific test methods |
| EN 55011: 2007 | Limits and Methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment (EMC) |
| EN60529 : 1992 | Specifications for degrees of protection provided by enclosures |

- The variable frequency drive ampere rating shall be equal to or greater than the ampere rating listed on the motor being driven by the variable frequency drive.
2. The drive units shall be modularly constructed. Printed circuit boards shall be connected in such manner that they are easily removed from the unit. Power components shall be readily accessible and be connected in such manner that they are easily removed from the unit. The pump drive shall be freestanding for wall mounting or cabinet installation construction, for 230-480V, 60HZ 3Phase supply and shall be rated for IP55 and IP66 isolation class.
- C. System Operation – VFD with Integral Control or PLC and VFD Functionality
1. High/Low Level Sump Control:
 - a. The system shall provide automatic level control via means of a submersible pressure transducer (4-20mADC) and one (1) non-mercury liquid level float switch. A user-programmable Start Level shall indicate the point at which the pump will start. Upon activation the pump shall run at maximum speed for a pre-determined period, then ramp down to an energy efficient optimal speed, calculated by the system. When the water level reaches the Stop Level, the pump shall stop. The Optimal Speed shall either be calculated by the system or manually entered by the user.
 - b. In case of high inflow, the system shall increase pump speed until the water level begins to decrease. When the water level reaches the Stop Level, the pump shall stop.
 - c. In case of very high inflow, when a pump or pumps are unable to overcome the inflow conditions even at maximum speed, additional pumps shall be activated and run at maximum speed until the stop Level is reached. If water levels continue to rise, a High Level Alarm shall be activated.
 - d. The system shall incorporate a Minimum Speed function that prevents the pump from operating at speeds too low to move water based on the pump curve.
 2. Run Time Averaging:
 - a. The system shall provide capability to balance run times for even wear among available operable pumps. This shall be a function of the control system and not require external devices, such as an Alternating Relay. The function shall operate by determining a “random” start level based on the Start Level setting. The system shall determine a random start level independent of each other. The system shall determine new random start levels every 24 hours. The pump with the lowest random start level shall be first to start on any given pump cycle. Other pumps shall remain in Standby capacity in case the lead and/or lag pump shall not be able to lower the water level as described in the section above. By recalculating the random start levels every 24 hours, balanced run times are accomplished.
 3. Pump Cleaning Function:
 - a. The system shall incorporate a “self-cleaning” function to remove debris from the pumps. The cleaning shall be triggered by three circumstances:
 - 1) Soft Clogging: When motor current equals 20% or greater above rated motor current, in the drive, for a period of 7 seconds
 - 2) Hard Clogging: When motor current equals 80% or greater above rated current for a period of 0.01 seconds
 - 3) Schedule Cleaning: The system is pre-programmed to perform cleaning regularly
 - 4) 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, drive shall resume to automatic operation.
 - b. Sump Cleaning Function:

- 1) The system shall incorporate a sump cleaning function to ensure surface solids and grease is regularly removed from the sump. The sump cleaning function shall perform regularly when enabled by the operator. Sump cleaning shall consist of the following functions
 - 2) Sump cleaning is triggered when internal timer expires and during a normal pump down cycle
 - 3) Pump is automatically ramped to maximum speed
 - 4) Pump runs at maximum speed for designated time or until the pump are snoring."
 - 5) When Sump Cleaning is over, the pump is shut off and resumes normal operation.
- c. Pipe Cleaning Function:
 - 1) The system shall incorporate a pipe cleaning function to avoid discharge pipe sedimentation and clogging due to reduced pump speed. This shall be an automatic feature that initiates with every pump cycle. Upon reaching Pump Start Level, the system shall operate the pump at 100% speed for a determined time before ramping down to the most energy efficient speed for the duration of the cycle.
- d. Energy Efficiency Speed Finder:
 - 1) The system shall provide a function that automatically calculates the most energy efficient speed for the pump based on station inflow characteristics. An algorithm calculates the optimal speed whereby the most water is pumped using the least amount of energy, the optimal speed is constantly adjusted to account for changes inflow without requiring operator adjustment, multiple setpoints, etc.
 - 2)
- e. Alarms & Monitoring:

The system shall provide alarms and monitoring for the system, pump and sump. Alarms shall be presented on the display, via a Summary Alarm relay and via Modbus registers. All alarms, when occurring, shall remain active until reset. Alarms shall have a built-in 4 second delay to prevent nuisance tripping. Alarms shall be as follows:

 - 1) Pump Monitoring:
 - (a) Pump Over Temperature (thermal contacts in motor stator)
 - (b) Pump Seal Leak (Seal leakage sensor)
 - 2) Sump Monitoring:
 - (a) High Sump Level (via level float switch or submersible transducer)
 - (b) Submersible transducer Sensor Error (Submersible transducer is not connected, reports faulty values or the wrong start level is used)
 - 3) Pump drive Monitoring (includes, but not limited to):
 - (a) Drive Overcurrent
 - (b) Drive Overload Trip
 - (c) Drive Overvoltage
 - (d) Drive Undervoltage
 - (e) Drive Overtemperature (internal)
 - (f) Drive Overtemperature (ambient)
 - (g) Drive Undertemperature (ambient)
 - (h) Input Phase Loss
 - (i) Drive Output Max Torque Exceeded

D. Submersible Pressure 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. The unit shall be set to operate at 16.4 Feet for this application.
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. The design without sharp edges prevents particles, textiles and paper from sticking to the housing or the diaphragm. The transducer shall be surge resistant.
8. The transducer power cable shall be steel reinforced PUR cable with high tensile strength (2,000 lb).

PART 7 – PUMP STATION VALVES

7.01 PUMP STATION VALVES

- A. The system supplier shall furnish 2 check valves, 2 knife gate valves and the number of air vacuum/air release valves as shown on the plans. These items shall be shipped loose for installation in the pump station valve vault and along the force main as required. Piping, fittings, bolts, gaskets in the valve vault and along the force main shall be supplied by the contractor.

7.02 PUMP STATION VALVES – SUPPLY AS SHOWN ON THE PLANS

- A. Plug valves shall be of the non-lubricating, eccentric type and shall be designed for a working pressure of 175 psi for valves 12" and smaller, 150 psi for valves 14" and larger. Valves shall provide tight shut-off at rated pressure. Valve shall be manufactured by Henry Pratt. Valves 20" and smaller shall have round port design. Minimum port area for all valves shall be 80% of corresponding pipe area.
- B. The plug valve body shall be cast iron ASTM A126 Class B with welded-in overlay of 90% nickel alloy content on all surfaces contacting the face of the plug. Sprayed, plated, nickel welded rings or seats screwed into the body are not acceptable. The valve plug shall be cast iron ASTM A126 Class B, with Buna N resilient seating surface to mate with the body seat. Valve flanges shall be in strict accordance with ANSI B16.1, Class 125.

- C. Plug valve shall be furnished with permanently lubricated sleeve type bearings conforming to AWWA C504. Bearings shall be of sintered, oil impregnated type 316 stainless steel ASTM A-743 Grade CF-8M or bronze ASTM B-127. Valves shaft seals shall be of the "U" cup type, in accordance with AWWA C504. Seals shall be self adjusting and repackable without moving the bonnet from the valve. 6" and smaller exposed valves shall be provided with wrench actuators. 8" and larger exposed valves shall be provided with worm gear type manual actuators. All buried valves shall be provided with worm and gear actuators suited for the intended service.
- D. Swing check valves are of self-contained free swinging disc style. Valves conform to all standards set forth in AWWA C508. Valve hinge pins are Stainless Steel and conform to the industry standards set forth for cushion valves. Manufacturer should have a minimum of ten years experience supplying AWWA C508 valves. Valves shall conform to ANSI B16.1: Cast Iron Pipe Flanges and Flanged Fittings Class 25,125,250 and 800 and AWWA C508: Swing Check Valves for Waterworks Service, 2" through 24" NPS. Valves are rated for 200 p.s.i. water working pressure. All testing is done in accordance with AWWA C508. Valves have integrally cast flat face flanges in accordance with ANSI B16.1 Class 125. All cast iron used conforms to ASTM A126 CLB. Valve Hanger and Disc are of cast iron conforming to ASTM A126 CLB. Hinge Pins conform to ASTM A276 GR304. Seat Rings are of Low Zinc Bronze conforming to ASTM B62 or of Stainless Steel conforming to ASTM A276 GR316. Internal and external coatings are high build two component epoxy conforming to AWWA C550. All valves meet the standards of AWWA C508 All valves utilize a single disc mounted to a clevis hinge which prevents the disc from tipping. The valve disc swings open once the pump starts and allows for full flow. When closed the valve offers a tight shut-off. Valve body and cover are of Cast Iron, valve hinge is of Cast Iron. Disc seating surface is either Bronze, Stainless Steel or of Buna-n depending on application. Valve seat rings are of Bronze or Stainless Steel. The valve body has a bolted cover design and flanges are integral to body casting –not wafer style. Valve body and disc are designed in such a way as to minimize turbulence. Spring systems are externally mounted on the side of the body and do not come into contact with main line media. Markings on the valves are in accordance with AWWA C508, and include the name of manufacturer, the year of manufacture, maximum working pressure and size of valve. All valves are built for horizontal installation. However, all valves operate equally well in the vertical installations.
- E. Knife Gate Valves shall be of the Bonneted type, rated for 150 PSI CWP. Flanges shall be drilled and tapped to ANSI B16.5, Class150 pound standard with raised faces. Flange raised face shall be machined using serrated-spiral or serrated-concentric grooves with a 125-250 RMS finish. Valve bodies shall be cast CF8 or CF8M stainless steel (304ss).The valve bonnet shall be fabricated with 304stainless steel liner, packing box and bonnet flange raised face. Bonnet flange and stiffeners shall be 304 stainless steel. A gate wiper shall be used between the bonnet flange and the body top flanges. The wiper material shall be UHMWPE. Valve shall have 304 gate and integral cast stainless steel seat in the valve body. Gate shall be of design and thickness to withstand full 150 PSI rated pressure without permanent deflection to the gate. Gate shall have a rounded, beveled bottom. Seat and gate shall have a fully machined finish for one way shutoff. Minimum of two gate wedges shall be provided to assist seating of the gate against the seat in the lower half of the valve body. Gate guides shall be provided in the upper half of the valve body. Packing gland shall be cast stainless steel (CF8/CF8M). Packing shall be Teflon lubricated synthetic packing with a minimum of 4 rows of packing. Packing gland bolts, studs and nuts shall be 304 Stainless steel. Valve yoke shall be cast CF8 (304) stainless steel. Yoke shall be the flat top design to allow bolt-on field installation or conversion of actuators without welding or machining. Valve stem shall be 304 stainless steel (same material grade as bonnet liner) with full ACME threads. Stem nut shall be bronze. Stem nut shall be enclosed by the use of a cast stainless steel retainer. Manually actuated valves shall be hand wheel operated for all sizes. Bevel gear operators are recommended for valves 16" and above where frequent operation is required and/or where used in applications above 75 PSI. Valves shall be designed, manufactured and tested to MSS SP-81 standard or AWWA C520 standard.

- F. Air and Vacuum Valves, where required, shall have the following functions: continuous discharge of dis-entrained pressurized air/gas, unrestricted vacuum break, and pipeline surge protection in a single chamber. Valves shall be anti-surge and anti-shock air release and vacuum break valves. The small orifice shall release air accumulations after the pipeline is filled, under pressure and in operation. The valve shall be equipped with an integral surge alleviation mechanism that automatically dampens surge pressures due to rapid air discharge or the subsequent rejoining of separated water columns. The valves shall be designed with the following features and materials of construction:
1. The intake/discharge orifice area is equal to the nominal size of the valve, i.e., an 8" valve shall have 8" full flow inlet and 8" outlet.
 2. Nozzle and Anti-Shock floats shall be solid unbreakable HDPE that will not deform under twice the design working pressure.
 3. Manufacturer shall have ISO 9001, and third party vacuum testing to certify sizing and performance. CFD, FEA or other types of theoretical modeling are not acceptable.
 4. Valve shall have a 10 year in-service warranty for all internal components.
 5. 304 Stainless Steel Body, Flange, Top Cover and Fasteners
 6. 316 Stainless Steel Nozzle & Lower Float Assembly
 7. Integral High Density Polyethylene Anti-Shock and Nozzle Floats
 8. EPDM Seats and Seals
 9. Tangential top and bottom Flushing Ports.

PART 8 - EXECUTION

8.01 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.

8.02 PREPARATION

- A. Make corrections and/or repairs as required for items inspected and found to be deficient.

8.03 INSTALLATION

- A. Install pumps and accessories in strict accordance with the manufacturer's instructions.

8.04 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.

8.05 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.

8.06 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 9 - SERVICE AND WARRANTY**9.01 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.

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 24 - 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