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DEC 22 2015

APPROVAL EXPIRES
DEC 22 2018
TENN DEPT OF ENVIRONMENT & CONSERVATION
DIVISION OF WATER RESOURCES

THE CITY OF
CLARKSVILLE
TENNESSEE'S TOP SPOT

APPROVAL SHALL NOT BE CONSTRUED AS CREATING A PRESUMPTION OF CORRECT OPERATION OR AS WARRANTING BY THE COMMISSIONER THAT THE APPROVED FACILITIES WILL REACH THE DESIGN GOAL FOR THE COMMISSIONER TITLE
BY *Adnan Baha* *Eps II*

WP15-0708

STANDARD WATER AND SEWER SPECIFICATIONS



APPROVAL EXPIRES
NOV 21 2014
TN DEPT OF ENVIRONMENT & CONSERVATION
DIVISION OF WATER POLLUTION CONTROL

Honorable Kim McMillan, Mayor
Pat Hickey, General Manager
Brian C. Goodwin, P.E., Chief Utility Engineer

SEE DEPT. OF ENVIRONMENT & CONSERVATION DIVISION OF WATER POLLUTION CONTROL DIVISION IS HEREBY APPROVED FOR CONSTRUCTION BY THE COMMISSIONER

NOV 21 2011

"PROV." SHALL NOT BE CONSTRUED AS CREATING A PRESUMPTION OF CORRECT OPERATION OR AS WARRANTING BY THE COMMISSIONER THAT THE APPROVED FACILITIES WILL REACH THE DESIGNED GOALS FOR THE COMMISSIONER TITLE
BY *Adnan Baha*



WPC11-0530

RECEIVED

OCT 27 2011

TN Division Of Water
Pollution Control



2215 Madison St.
P.O. Box 387
Clarksville, TN 37041-0387

Phn: 931.645.7418
www.clarksvillegw.com

Date of Issue: _____

Set No. _____

STANDARD WATER AND SEWER SPECIFICATIONS



Honorable Kim McMillan, Mayor
Pat Hickey, General Manager
Brian C. Goodwin, P.E., Chief Utility Engineer

WS 12 10 11

APPROVAL EXPIRES
DEC 31 2015
TENN DEPT OF ENVIRONMENT & CONSERVATION
DIVISION OF WATER SUPPLY



2215 Madison St.
P.O. Box 387
Clarksville, TN 37041-0387

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STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER RESOURCES
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, Tennessee 37243
PHONE: 615-532-0191 FAX: 615-532-0686

November 3, 2015

Mr. Brian Goodwin, PE
Clarksville Water Department
2215 Madison Street
Clarksville TN 37043

Re: Clarksville Water Department (PWSID# 0000116)
Montgomery County
Project Number WS 12-1041
Standard Water Line Construction Specifications

Dear Mr. Goodwin:

We acknowledge receipt of a request for an extension of our approval of the above referenced specifications. We have reviewed this request and found it acceptable. Our approval is hereby extended three years and will expire on December 31, 2018. If you have any questions contact us at (615) 532-0191.

Sincerely,

R. William Hench, P.E.
Drinking Water Engineering
Division of Water Resources

cc: Nashville Field Office - Water Resources

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MEASUREMENT AND PAYMENT

PART 1 - GENERAL

- 1.01 All work items described herein shall include all labor, materials, equipment, appurtenances, taxes, freight, excavation, shoring, dewatering, bedding, backfill, compaction, landscaping, paving, clean-up, testing, disinfection, mobilization and demobilization, insurance, overhead and profit required to complete the specific item of work.
- 1.02 Items eligible for reimbursement shall be measured and reimbursed as addressed on the Bid Form. Work not specifically addressed on the Bid Form shall be considered incidental to the overall job and included in other major items of construction.
- 1.03 The Bidder declares that he has examined the site of the work and informed himself fully in regard to all conditions pertaining to the place where the work is to be done; that he has examined the Plans, Specifications and Contract Documents for the work, and has read all special provisions furnished prior to the opening of bids; and that he has further satisfied himself relative to the work to be performed. The Bidder further declares that he understands that unit quantities shown on the Bid Form (unless lump sum project) are approximate only, are subject to increase or decrease, and that, should the quantities of any of the items be decreased, the Bidder will make no claim for the anticipated profits. In addition, the Owner also reserves the right to adjust quantities, either by addition or deletion and as-Bid unit prices shall remain in effect for these quantity adjustments.
- 1.04 The Contractor shall note that all excavation is unclassified. No separate payment will be made for rock excavation, unless otherwise noted.
- 1.05 No extra payment will be made for increase in pipe cover from the minimum. It is possible that over-excavation, in addition to the notations included on the Drawings, will be required to avoid existing utilities and to comply with proposed earthwork and storm drainage features included on certain projects.
- 1.06 On or before the fifteenth (15th) day of each calendar month, the City shall process all pay requests received prior to the fifth (5th) day of the month and make partial payments to the Contractor on the basis of a duly certified and approved estimate of work performed during the preceding calendar month by the Contractor, less five percent (5%) of the amount of such estimate which is to be retained by the City until all work has been performed strictly in accordance with the agreement and until such work has been accepted by the City.

PART 2 - NOT USED

PART 3 - EXECUTION

3.01 02010 GENERAL MISCELLANEOUS SPECIFICATIONS

Any item not specifically listed for payment on the Bid Form shall be considered to be incidental to the overall job and included in the price of other related items on the Bid Form.

3.02 02110 CLEARING AND GRUBBING

Measurement of clearing and grubbing area will not be made. Payment for clearing and grubbing shown on the Contract Drawings or specified herein is not a separate pay item and is considered incidental to the overall job and included in other major items of construction.

3.03 02200 EROSION PREVENTION AND SEDIMENT CONTROL

Items eligible for reimbursement shall be measured and reimbursed as addressed on the Bid Form. Work not specifically addressed shall be considered incidental to the overall job and included in other major items of construction. Maintaining and re-establishing temporary erosion prevention and sediment control measures until permanent stabilization is established is considered part of this item and extra payment shall not be made for such.

3.04 02221 TRENCHING, BEDDING AND BACKFILLING

- A. Pipeline trenching, bedding and backfilling, including solid rock excavation, sheeting, shoring and bracing, dewatering, hauling, placing, compaction and disposal will not be measured for payment unless specifically listed on the Bid Form.
- B. Payment for trenching, bedding and backfilling as stipulated above, will be included in the Contract unit price for the items with which they are associated.
- C. When rock excavation is specified as a payment item on the Bid Form, the payment for rock excavation shall be by the cubic yard removed and disposed of as approved by the Engineer. Normally, the cubic yard measurements shall be made by taking the profile of the rock, a width up to 36 inches and the length of the rock excavated. For large diameter pipe (greater than 12"), measurements shall be made by taking the profile of rock, a width up to the nominal diameter of the pipe plus 24" and the length of rock excavated. If payment is specified by the linear foot, the length of trench involving solid rock excavation will be measured.
- D. Crushed Stone for Undercut Replacement:
 - 1. Crushed stone used for undercut replacement of unsuitable material that has been excavated below planned subgrade, including hauling, placing and compacting, will be measured for payment by the ton in place. This item includes undercutting and disposal of unsuitable material. This item does not include crushed stone placed to provide a protective granular envelope around pipe placed in solid rock cuts.

2. Crushed stone for undercut bedding as above stipulated will be paid for at the Contract unit price per ton as determined by weight tickets and by inspection of the City Engineer or his designated representative. At the discretion of the City Engineer, the Contractor will be required to submit profiles justifying the quantity of crushed stone required for undercut replacement.

E. Crushed Stone for Pavement Maintenance and Shoulder Replacement:

1. Crushed stone for pavement maintenance and shoulder replacement including hauling, placing, blading, and compacting will be measured for payment by the ton in place.
2. Crushed stone for pavement maintenance and shoulder replacement as above stipulated will be paid for at the Contract unit price per ton as determined by weight tickets.

3.05 02410 CLEANUP AND RESTORATION

Items eligible for reimbursement shall be measured and reimbursed as addressed on the Bid Form. Work not specifically addressed shall be considered incidental to the overall job and included in other major items of construction. The Owner may retain sufficient amounts from payment requests on other major completed items to ensure that all cleanup and restoration is properly and promptly completed.

3.06 02485 LAWN AND GRASS LANDSCAPING

- A. Landscaping shall be measured for payment on the basis of area and volume measurements for work performed and accepted including fertilizing, mulching and watering as required.
- B. Payment for landscaping as stipulated above will be by the Contract unit price for the various classifications shown on the Bid Form.
- | | | |
|----|-----------------------|-----------------------|
| 1. | Topsoil | Per Contract pay unit |
| 2. | Seeding with mulch | Per Contract pay unit |
| 3. | Seeding without mulch | Per Contract pay unit |
| 4. | Sprigging | Per Contract pay unit |
| 5. | Sodding | Per Contract pay unit |
- C. When landscaping items are not specifically listed on the Bid Form, the cost and payment for these items shall be considered incidental and included in other major items of work on the Bid Form.

3.07 02575 PAVEMENT REPAIR

Items eligible for reimbursement shall be measured and reimbursed as addressed on the Bid Form. Work not specifically addressed shall be considered incidental to the overall job and included in other major items of construction. Pavement work may be listed in square units, linear units, or tons. Square units or tons will reflect the total area replaced while linear units will be based on the distance which the installed utility crosses the material to be replaced, in which case the width of repair will not be taken into account.

3.08 02713 WATER DISTRIBUTION SYSTEMS

- A. Water pipe will be measured by the linear foot of pipe installed, tested, disinfected and accepted including trenching, bedding, backfill, fittings (unless otherwise specified), thrust blocking and metallic tape and/or detector wire, when required.
- B. Water pipe as above stipulated will be paid for at the Contract unit price per linear foot for the various sizes and classifications shown on the Bid Form.
- C. Water pipe installed in connection with Boring and Jacking, Tunneling, or Horizontal Directional Drilling shall be measured for payment in accordance with Paragraphs 3.11, 3.12 and 3.13 of this Section.
- D. Valves, hydrants and service assemblies will be measured by the number installed, tested, disinfected and accepted including trenching, backfill, fittings (unless otherwise specified), and thrust blocking.
- E. Valves, hydrants and service assemblies, as above stipulated, will be paid for at the Contract unit price per each for the various sizes and classifications shown on the Bid Form.
- F. Water line fittings will be measured for payment only specifically indicated for on the Bid Form and will be measured by the weight of fittings installed, tested, disinfected and accepted.
- G. Fittings, as above stipulated, will be paid for at the Contract unit price per pound or by ton. If compact fittings are installed, the corresponding compact weights will be used.
- H. Fitting weight will include the gland and accessories. Unless otherwise specified or shown on the drawings, the weights shall include the specified joint restraint.
- I. Inspection, testing and disinfection are not pay items and shall be considered incidental to the overall job and included in other major items of construction.

3.09 02715 FIRE SERVICE WATER METERS

Payment for fire service water meters shall be as set forth on the Bid Form and shall include all work and materials required to provide a complete installation as shown on the Contract Drawings.

3.10 02722 SANITARY SEWER SYSTEMS

- A. Gravity sewer pipe shall be measured by the linear foot in terms of the horizontal length of pipe installed, tested and accepted as measured along the centerline, with no deduction for manholes or fittings. Such payment shall be considered full compensation for furnishing and installing sewer pipe in accordance with the Contract Drawings and Specifications, including trenching, bedding, backfill, fittings (unless otherwise specified), shoring, dewatering and all other work necessary for and incidental to completion of the work.
- B. Gravity sewer pipe as above stipulated shall be paid for at the Contract unit price per linear foot for the various sizes, pipe material and classifications shown on the Bid Form. Measurement of the depth to determine depth classification shall be the vertical distance

between the original ground surface elevation and the invert of the pipe as shown on the Contract Drawings except where the profile has been revised and approved by the Owner.

- C. Sewer pipe installed in connection with Boring and Jacking, Tunneling, or Horizontal Directional Drilling shall be measured for payment in accordance with Paragraphs 3.11, 3.12 and 3.13 of this Section.
- D. Pipe connections to existing manholes shall be paid for at the Contract unit price. Payment shall include all work necessary to core into existing structure, install resilient pipe connector, install new pipe and reshape existing manhole invert.
- E. Sewer service assemblies shall be measured by the number installed, tested and accepted. This item shall include the complete installation of service fittings, saddles, manhole connections, service pipe, sewer risers, cleanouts and reconnection of existing sewer services to new connections as indicated on the Contract Drawings.
- F. Sewer service assemblies as stipulated above shall be paid for at the Contract unit price for each of the various classifications as shown on the Bid Form.
- G. Manholes shall be measured by the number installed, tested and accepted for each type of manhole and applicable depth. This item includes excavation, granular sub-base, concrete foundation, pre-cast sections, manhole steps, standard castings, concrete invert, pipe openings and watertight resilient pipe connectors, backfill and trench check dam, and other items as required for a complete installation. Measurement of the depth to determine depth classification shall be the vertical distance from the finished casting elevation to the invert of the outlet pipe as shown on the Contract Drawings except where the profile has been revised and approved by the Owner.
- H. Manholes as above stipulated shall be paid for at the Contract unit price per each for the various depth classifications shown on the Bid Form.
- I. Manhole castings, except the watertight type, shall not be measured for payment, but shall be included in the unit price per manhole. Watertight manhole castings shall be measured by the number installed and accepted and shall be paid for at the Contract unit price per each installed and accepted as shown on the Bid Form.
- J. Measurement and payment for manhole drop assemblies shall be lump sum for each drop assembly construction. Payment for the affected manhole will be paid separately under the manhole pay item.
- K. Vent assemblies shall be measured by the number installed, inspected and accepted and shall be paid for at the Contract unit price per each unit installed.
- L. Sewer force main pipe shall be measured by the linear foot in terms of the horizontal length of pipe installed, tested and accepted as measured along the center line with no deductions for valves or fittings. Such payment shall be full compensation for furnishing and installing force main pipe in accordance with the Contract Drawings and Specifications, including trenching, bedding, shoring, dewatering, backfill, specially coated and lined ductile iron fittings (unless

otherwise specified), thrust blocking, identifying tape and detector wire, joint restraint and all other work necessary for and incidental to completion of the work.

- M. Sewer force main pipe as above stipulated shall be paid for at the Contract unit price per linear foot for the various sizes, pipe material and classifications as shown on the Bid Form. Measurement of the depth to determine depth classification shall be the vertical distance between the original ground surface elevation and the invert of the pipe as shown on the Contract Drawings except where the profile has been revised and approved by the Owner.
- N. Specially coated and lined ductile iron fittings will be measured for payment only when specifically indicated on the Bid Form and will be measured by the weight of the fittings installed, tested and accepted. If compact fittings are installed, the corresponding compact weights shall be used. The weight of joint restraints or thrust blocking is not to be included in the measurement.
- O. Fittings as stipulated above shall be paid for at the Contract unit price per pound or ton as shown on the Bid Form.
- P. Except where included in other major items of construction, such as a lump sum pump station, sewer valves shall be measured for payment in accordance with Paragraph 3.16 of this Section.
- Q. Unless indicated otherwise on the Bid Form, concrete for caps, collars, anchors, thrust blocking, encasement, etc. as indicated on the Contract Drawings are not pay items and are considered incidental to the overall job and included in other major items of construction. Concrete ordered in the field by the engineer or inspector for pipe protection or otherwise shall be measured for payment by the cubic yard in place as determined by batch tickets and paid for at the Contract unit price as set forth on the Bid Form.
- R. Pipe protection may be alternately specified to allow ductile iron pipe to be used in lieu of PVC sewer pipe with concrete encasement. Where ductile iron is allowed as a substitute it will be paid for as an extra for pipe protection. If ductile iron pipe is specified as a line item it will be paid for according to that line item only.
- S. Bypass pumping or pumping and hauling shall be considered incidental to the overall job and included in other major items of construction. No separate payment shall be made for this work unless specifically indicated as a pay item on the Bid Form.
- T. Inspection and testing are not pay items and shall be considered incidental to the overall job and included in other major items of construction.

3.11 02725 BORING AND JACKING

- A. Boring and jacking, including all work necessary for the installation, testing and disinfection (water only) of the casing and carrier pipe, casing spacers and end seals, shall be measured for payment by the linear foot of casing pipe installed or by lump sum as may be indicated on the Bid Form. No additional payment for the carrier pipe under other bid items will be made.
- B. No extra payment shall be provided if rock is encountered, even in the event that the proposed bore must be tunneled. The Contractor shall provide whatever means necessary to

complete bores even if rock is encountered. All line items referencing boring and jacking shall include boring or tunneling as required. No change orders shall be issued if rock is encountered.

3.12 02726 TUNNELING

Tunneling shall be a pay item only where indicated specifically on the Bid Form. Tunneling performed where Boring and Jacking has been proposed will be measured and paid as Boring and Jacking. Where specifically indicated on the Bid Form, tunneling, including all work necessary for the complete installation and testing of the tunnel liner plate and carrier pipe, grouting, casing spacers, strapping, masonry bulkheads, backfill of the tunnel, etc. shall be measured for payment by the linear foot or by lump sum as may be indicated on the Bid Form. No additional payment for the carrier pipe under other bid items will be made.

3.13 02727 HORIZONTAL DIRECTIONAL DRILLING

The price for horizontal directionally drilled lines shall be priced complete and shall include the drilling, installation of pipe, testing, disinfection (for water mains), including labor, materials, equipment and all other work incidental thereto, complete in place, and shall be measured for payment by the linear foot along the centerline of the pipe or by lump sum as may be indicated on the Bid Form. No extra payment shall be provided if rock is encountered, even if rock drilling techniques are required. No additional payment for pipe under other bid items will be made.

3.14 02821 CHAIN-LINK FENCES AND GATES

Except where included in other major items of construction, such as a lump sum pump station, chain-link fences and gates shall be measured and paid as set forth on the Bid Form. Payment shall be full compensation for this items and for all labor, materials and equipment required to provide a complete installation as shown on the Contract Drawings.

3.15 03300 CAST-IN-PLACE CONCRETE

Unless indicated otherwise on the Bid Form, concrete for caps, collars, anchors, thrust blocking, encasement, cast-in-place structures, such as manholes, valve vaults, wet wells, etc. as indicated on Contract Drawings are not pay items and are considered incidental to the overall job and included in other major items of construction. Concrete ordered in the field by the Engineer or Inspector for pipe protection or otherwise shall be measured for payment by the cubic yard in place as determined by batch tickets and paid for at the Contract unit price as set forth on the Bid Form.

3.16 11200 SEWER VALVES

Except where included in other major items of construction, such as a lump sum pump station, sewer valves shall be measured for payment at the Contract unit price as indicated on the Bid Form for each type of valve installed including all valves, valve boxes, vaults and hatches, manholes and castings and all incidental work required to complete the installation.

3.17 11311 SUBMERSIBLE SEWAGE PUMP STATIONS

Payment for submersible sewage pump stations shall be as set forth on the Bid Form and shall include

all work and materials required to provide a complete installation as shown on the Contract Drawings.

3.18 11330 HYDRAULIC SEWAGE GRINDERS

Except where included in other major items of construction, such as a lump sum pump station, payment for sewage grinders shall be as set forth on the Bid Form and shall include all work and materials required to provide a complete installation as shown on the Contract Drawings.

3.19 11410 WET WELL MOUNTED, SUCTION LIFT SEWAGE PUMP STATIONS WITH DUPLEX PUMPS

Payment for wet well mounted, suction lift sewage pump stations with duplex pumps shall be as set forth on the Bid Form and shall include all work and materials required to provide a complete installation as shown on the Contract Drawings.

3.20 11411 WET WELL MOUNTED, SUCTION LIFT SEWAGE PUMP STATIONS WITH SERIES PUMPS

Payment for wet well mounted, suction lift sewage pump stations with series pumps shall be as set forth on the Bid Form and shall include all work and materials required to provide a complete installation as shown on the Contract Drawings.

3.21 11420 LOW PRESSURE GRINDER PUMP STATIONS

Payment for low pressure grinder pump stations shall be as set forth on the Bid Form and shall include all work and materials required to provide a complete installation as shown on the Contract Drawings.

3.22 13310 FIELD INSTRUMENTATION

Except where included in other major items of construction, such as a lump sum pump station, field instrumentation shall be measured and paid as set forth on the Bid Form and shall include all work and materials required to provide a complete installation as shown on the Contract Drawings.

3.23 DIVISION 16 ELECTRICAL SPECIFICATIONS

Items eligible for reimbursement shall be measured and reimbursed as addressed on the Bid Form. Work not specifically addressed on the Bid Form shall be considered incidental to the overall job and included in other major items of construction.

END OF SECTION

GENERAL MISCELLANEOUS SPECIFICATIONS

PART 1 – GENERAL

There are some miscellaneous guidelines that exist for performing work in the City of Clarksville. These are general in nature and are itemized below:

- 1.01 Design of utility-related projects shall comply with the provisions of the Subdivision Regulations prepared by the Clarksville-Montgomery County Regional Planning Commission.
- 1.02 Changes to bid documents are acceptable only if they are made with the prior agreement of the City Engineer's Office or their designated representative prior to submission of a bid and issued as a change in an Addendum.
- 1.03 Any item not specifically listed on the Bid Form shall be considered to be included in the price of other related items on the Bid Form, or otherwise considered incidental to the scope of the Contract.
- 1.04 All survey elevations shall be referenced to mean sea level (msl). Elevation references to temporary benchmarks not referenced to mean sea level shall be rejected.
- 1.05 A permit must be completed prior to beginning any water and/or sewer construction. Permits are located at the City Engineer's Office. There is no fee associated with the permit.
- 1.06 Pre-construction photographs and/or video shall be taken on projects performed for the City of Clarksville, with particular attention to improved areas, to aid in restoring landscaping and other features to their initial condition.
- 1.07 Where utilities are installed in new fill, a compaction letter sealed by a Geotechnical Engineer registered in the State of Tennessee shall be submitted to the owner prior to accepting said utilities. An acceptable compaction letter shall state that field density testing indicates the fill has been compacted to at least 95% of the maximum dry density according to the Standard Proctor. Special protection such as use of ductile iron pipe with joint restraint may be required. In special instances and cases where compaction letters may not have been requested for fill slopes the Engineer retains the right to request additional testing and/or remedies for insuring the integrity of the installed utilities and surrounding property.
- 1.08 Where water and sewer services cross street curbs, the curbs shall be stamped with the letter "W" or "S" as appropriate. The end of each service stub shall be marked with a 6-foot long 4x4 wooden post or metal fence post embedded 2 feet into the ground. The post shall be marked with blue paint for water services and green paint for sewer services.
- 1.09 Insulated minimum 14-gauge tracer wire shall be installed as specified herein along all pressurized water and sewer lines regardless of pipe material.

- 1.10 Upon completion of the installation of the sanitary sewer and water line improvements and prior to acceptance by the City of Clarksville, the Contractor shall submit one (1) hardcopy and one (1) electronic copy on CD in AutoCad .dwg format of the record drawings.
- A. All drawings shall be referenced to Tennessee State Plane Coordinates (NAD27).
 - B. The record drawings shall also include detailed valve locations showing a minimum of three measurements to permanent features. Also, water lines shall be adjusted to the as-built locations by snapping the lines correctly to the adjusted valve location for each valve or valve cluster.
 - C. The as-built submission should also be accompanied by a text file, which will include points in State plane format and point type (Ex. 788870.372, 1568830.499, Fire Hydrant). At a minimum, the text file should include all valves, hydrants, manholes, wet wells, benchmarks, water and sewer service markers. Additionally, manhole and wet well data should include as-built rim elevations and invert elevations. Benchmark data should include elevation and description.
 - D. The City of Clarksville will not execute the Final Plat of the development until such time that the as-built drawings and text files are received.
 - E. A Certificate of Occupancy will not be issued by Clarksville Building and Codes until such time that the as-built drawings and text files are received.
- 1.11 All lift station property, including the dedicated access road, shall have a recorded deed submitted with final plat to the City Engineer's Office prior to final acceptance by the City.
- 1.12 Prior to bacteriological testing and acceptance of newly installed water mains, Contractor shall complete, sign and submit a "Disinfection, Flushing, and Pressure Testing Worksheet" to the City's Inspector. A copy of this sheet is available in Section 02713 of these specifications.
- 1.13 All electrical wiring shall be copper conductor. Aluminum is not an acceptable substitute. All control and instrument panels shall be supported by galvanized steel posts set in concrete. Wooden posts are not acceptable.
- 1.14 Utility work necessary for after normal business hours may be required to be performed by all contractors and subcontractors working on or adding to the City's various systems at the direction of the City Engineer or his designated representative. Work of this nature may be necessary to limit impact to the utility customers and will not be considered for additional payment.
- 1.15 The contractor shall be responsible for handling sewage flows during construction by furnishing adequate bypass pumping for the duration of the project. No bypassing of sewage shall be permitted. Unless specified elsewhere, all costs associated with handling sewage flows shall be borne by the contractor.

1.16 WARRANTIES

- A. The developer and/or Contractor shall warrant all utilities and related appurtenances for a one (1) year period (minimum) following testing and acceptance by the City. The Contractor agrees that he will obtain from the manufacturers or equipment and materials furnished under this Contract, guarantees against defective materials and workmanship, and if those guarantees furnished by the manufacturer do not extend for the term of one (1) year from and after the date upon which the final estimate is formally approved by the City or other established date as set forth hereinbefore, he shall make the necessary arrangements and assume all cost for extending this guarantee for the required period.
- B. The Contractor shall promptly make such repairs or replacement as may be required under the above specified guarantee, and, when the repairs or replacements involve one or more items of installed equipment, shall provide the services of qualified factory-trained servicemen in the employ of the equipment manufacturers to perform or supervise the repairs or replacements.
- C. When the Engineer or the City deems it necessary, and so orders, such replacements or repairs under this section shall be undertaken by the Contractor within twenty-four (24) hours after service of notice. If the Contractor unnecessarily delays or fails to make the ordered replacements or repairs within the time specified, or if any replacements or repairs are of such nature as not to admit of the delay incident to the service of a notice, then the City shall have the right to make such replacements or repairs, and the expense thereof shall be paid by the Contractor or deducted from any moneys due the Contractor. The Performance Bond shall remain in full force and effect throughout the Warranty Period.

1.17 Where a developer's preferred choice of sewerage a property or subdivision is by pumping sewage from the development to a discharge point in the City's existing sewer system, a gravity sewer solution(s) shall also be submitted for consideration by the City Engineer's Office. Each sewer alternative shall include a construction cost estimate to aid in the comparison of the alternatives.

1.18 The equipment items furnished shall comply with all governing federal and state laws regarding safety, including all current requirements of the Occupational Safety and Health Act (OSHA). The Contractor shall be solely responsible for job safety in accordance with all laws, regulations, methods, etc. of OSHA and the state.

PART 2 – NOT USED

PART 3 – NOT USED

END OF SECTION

SECTION 02110

CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Clearing, grubbing, removal and disposal of vegetation, rocks, roots and debris within the limits of the work except objects designated on the drawings to remain.
- B. Preserve from injury or defacement all vegetation and objects to remain.

1.02 RELATED WORK

- A. Section 02200: Erosion Prevention and Sediment Control
- B. Section 02221: Trenching, Bedding and Backfilling

1.03 LIMITS OF WORK

- A. Rights-of-way or easement area established by Owner.
- B. Construction area including the area bounded by lines five feet outside the construction lines established by Owner.
- C. Approved borrow pit areas.
- D. Designated stockpiles of construction material other than borrow material.

1.04 PROTECTION

- A. The Contractor shall observe the requirements stated in Clarksville City Ordinance 1-1710, which describes the precautions required to protect any City trees. If the work entails removal of any trees on City owned property, the City Forester shall be notified in advance of removing the trees. City trees are described as any tree 6" diameter or greater that is located on City owned property or right-of-ways. The City Forester may permit removal of the tree(s), and in some instances may require replacement in kind with a tree(s) of equal size (i.e. one 6" diameter tree or three 2" diameter trees). The replacement requirements are described in City Ordinance 1-1708. These requirements must be included in any bid submittal and are considered incidental unless specifically addressed in the Bid Form.
- B. Protect living trees not marked for removal inside and outside the construction area. To protect trees from injury, erect construction fences around trees allowing one foot of space from the trunk for each inch of trunk diameter. Treat cut or scarred surfaces of trees or shrubs with a paint prepared especially for tree surgery.

- C. Protect benchmarks and existing structures, roads, sidewalks, paving and curbs against damage from vehicular or foot traffic.
- D. Maintain designated temporary roadways, walkways and detours, for vehicular and pedestrian traffic.
- E. Establish all erosion prevention and sediment control devices.

PART 2 - NOT USED

PART 3 - EXECUTION

3.01 PREPARATION

Maintain benchmarks, monuments and other reference points. Re-establish if disturbed or destroyed at no cost to Owner.

3.02 CLEARING AND GRUBBING

- A. Clear rights-of-way, borrow pit and other stockpile areas of objectionable material to the ground surface except for trees and stumps.
- B. Cut trees and stumps to within six inches of ground surface or low water level in swampy areas where embankments are to be constructed provided undercutting or other corrective measures are not stipulated.
- C. Cut trees and stumps outside the construction area marked for removal by the Owner to within six inches of the ground surface.
- D. Remove low hanging, unsound or unsightly branches on trees or shrubs designated to remain.
- E. Trim branches of trees extending over the roadbed to a clear height of twenty feet above the roadbed surface.
- F. Grub construction area of protruding obstructions except sound undisturbed stumps and roots six inches or less above the ground which will be a minimum of 5 feet below subgrade or embankment slope provided undercutting, topsoil stripping or other corrective measures are not stipulated.
- G. Grub borrow pit and stockpile areas of all objectionable material.
- H. Perform clearing and grubbing well in advance of construction or material removal activities.

3.03 DEBRIS REMOVAL

- A. No cleared or grubbed material shall be used in backfills or embankment fills.

- B. Promptly remove cleared debris from site unless property owner gives written permission for onsite disposal.
- C. Obtain permission from applicable regulatory authority for disposal of debris to waste disposal site.

END OF SECTION

EROSION PREVENTION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. This work shall consist of erosion control on all cut and fill operations, excavation, backfill, or other construction activities within the limits of the construction site, within any temporary or permanent easements, and within any borrow site used during the period of construction. The protection of these sites shall continue throughout the construction period.
- B. During flood seasons, protect the sites by sandbagging, the pumping of water, and any other means appropriate to restrain flooding. During dry weather, sprinkle the sites with water or use other means as necessary to provide dust control. In case of abnormally cold weather, any construction such as excavation work may be delayed until warmer weather or covered to prevent freezing.
- C. Either permanent stabilization or temporary seeding and mulching shall occur as soon as practical after final grade is achieved, but under no circumstances shall disturbed ground be exposed for longer than 14 days.
- D. The Contractor shall continuously maintain temporary erosion prevention and sediment control measures until permanent stabilization is established. The temporary pollution control provisions contained herein shall be coordinated with the permanent erosion control features, to ensure economical, effective, and continuous erosion control throughout the construction and post-construction period.
- E. All erosion prevention and sediment control work shall be in compliance with the City of Clarksville Storm Water Management Manual and the Tennessee Department of Environment and Conservation Erosion and Sediment Control Handbook. All projects shall comply with the State of Tennessee's Construction General Permit. The "General Permit for Discharges of Storm Water Associated with Construction Activities" may be reviewed in its entirety at <http://www.state.tn.us/environment/permits/conststrm.shtml>.

1.02 RELATED WORK

- A. Section 02410: Cleanup and Restoration
- B. Section 02485: Lawn and Grass Landscaping

PART 2 - PRODUCTS

2.01 TEMPORARY BERMS

- A. A temporary berm is constructed of compacted soil, with or without a shallow ditch, at the top of fill slopes or transverse to centerline on fills.
- B. These berms are used temporarily at the top of newly constructed slopes to prevent excessive erosion until permanent controls are installed or slopes stabilized.

2.02 TEMPORARY SLOPE DRAINS

A temporary slope drain is a facility consisting of stone gutters, fiber mats, plastic sheets, concrete or asphalt gutters, half round pipe, metal pipe, plastic pipe, sod, or other material that may be used to carry water down slopes to reduce erosion.

2.03 SEDIMENT STRUCTURES

Sediment basins, ponds, dewatering structures and traps are prepared storage areas constructed to trap and store sediment from erodible areas in order to protect properties and stream channels below the construction areas from excessive siltation.

2.04 CHECK DAMS

Check dams are barriers composed of large stones, sand bags, or other non-erodible materials placed across or partially crossing a natural or constructed drain way.

2.05 TEMPORARY SEEDING AND MULCHING

Temporary seeding and mulching are measures consisting of seeding, mulching, fertilizing, and matting utilized to reduce erosion. All cut and fill slopes including waste sites and borrow pits shall be seeded when and where necessary to eliminate erosion. Either permanent stabilization or temporary seeding and mulching shall occur as soon as practical after final grade is achieved, but under no circumstances shall disturbed ground be exposed for longer than 14 days.

2.06 BALED HAY OR STRAW CHECKS

- A. Baled hay or straw checks are temporary measures to control and prevent erosion.
- B. If approved, baled hay or straw checks may be used where the existing ground slopes toward or away from the embankment and shall follow the contour along the toe of slopes, in ditches, or other areas where siltation erosion or water runoff is a problem.
- C. Baled hay or straw checks can only be used in conjunction with silt fence or other approved methods as temporary control measures.

2.07 TEMPORARY SILT FENCES

Silt fences are temporary measures utilizing woven wire or other approved material attached to posts with filter cloth composed of burlap, plastic filter fabric, etc., attached to the upstream side of the fence to retain the suspended silt particles in the runoff water.

PART 3 - EXECUTION

3.01 PLANNING AND PERMITTING

- A. Unless otherwise provided, it shall be the basic responsibility of the Contractor to develop an erosion prevention and sediment control plan, including a Storm Water Pollution Prevention Plan (SWPPP), acceptable to the Engineer and the State of Tennessee.
- B. The Contractor shall submit a spill prevention plan to the Engineer for review. The contents of this spill prevention plan shall depend on what types of chemicals, lubricants and fuels will be used and if these will be stored on site. As a minimum, if fuel or lubricants or other chemicals are stored on site, either temporarily in vehicular tanks or in skid or trailer mounted tanks, a plan shall be supplied which directs all employees of the Contractor in the proper procedures to be followed should a spill occur. Under no circumstances shall spent oil wastes be discharged on the site. For more complex chemical storage requirements, a more complex plan will be required.
- C. The Contractor shall be responsible for filing the Notice of Intent (NOI) with the State. A sample copy of the NOI is included in [Appendix B](#). The complete application must be submitted at least 30 days prior to commencement of construction activities. Land disturbing activities shall not start until a Notice of Coverage is prepared and written approval by TDEC Division of Water Pollution Control is obtained.
- D. The Contractor shall be responsible for twice-weekly field inspection and documentation, and inspection after any storm event (0.5 inches or greater) of all erosion prevention and sediment control devices to insure that all devices are in fully operable condition. A sample copy of the Construction Stormwater Inspection Certification form has been included in [Appendix C](#). Copies of completed forms shall be made available to the City Engineer's Office upon request.
- E. Upon completion of construction, the Contractor shall be responsible for filing Notice of Termination (NOT) with the State. A sample copy of the NOT is included in [Appendix D](#).
- F. The project drawings and SWPPP indicate the minimum erosion prevention and sediment control measures required for this job. If the Contractor desires to stockpile construction materials, stone, earth, etc., the location of it and protection thereof shall be outlined in an Erosion Prevention and Sediment Control Plan to be submitted to the Engineer for review.

- G. The Contractor shall ensure that all erosion prevention and sediment control documents, including the SWPPP and any permits obtained, shall be available at the project site at all times.

3.02 PRE-CONSTRUCTION CONFERENCE

At the Pre-Construction Conference, the Contractor shall meet with the Engineer and go over in detail the expected problem areas in regard to the erosion prevention and sediment control work. The Contractor shall submit for acceptance his schedule for accomplishment of temporary and permanent erosion control work. He shall also submit for acceptance his proposed method of erosion control on haul roads and borrow pits and his plan for disposal of waste materials. No work shall be started until the erosion control schedules and methods of operations have been accepted by the Engineer.

3.03 CONSTRUCTION REQUIREMENTS

- A. The Engineer has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, the surface of erodible earth material exposed by excavation, borrow and fill operations, and to direct the Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds, or other water impoundment. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, slope drains, and use of temporary mulches, mats seeding or other control devices or methods as necessary to control erosion. Cut and fill shall be seeded and mulched as the excavation proceeds to the extent directed by the Engineer. Under no conditions shall the erodible earth material exposed at one time by clearing and grubbing exceed 5,000 linear feet for utility line work or one (1) acre without approval of the Engineer.
- B. The Contractor shall be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in his accepted schedule. Temporary pollution control measures not associated with permanent control features shall be used to correct conditions that develop during construction that were not foreseen during the pre-construction stage, prior to the installation of permanent pollution control features, or as needed to temporarily control erosion during normal construction practices.
- C. Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise erosion control measures may be required between successive construction stages.
- D. The Engineer will limit the area of excavation, borrow, and embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent pollution control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.
- E. Either permanent stabilization or temporary seeding and mulching shall occur as soon as practical after final grade is achieved, but under no circumstances shall disturbed ground be exposed for longer than 14 days.

- F. In the event of conflict between these requirements and pollution control laws, rules or regulations, or other Federal, State or Local agencies, the more restrictive laws, rules, or regulations shall apply.

3.04 CONSTRUCTION OF STRUCTURES

A. Temporary Berms

1. A temporary berm shall be constructed on compacted soil, with a minimum width of 24 inches at the top and a minimum height of 12 inches, with or without a shallow ditch, constructed at the top of fill slopes or transverse to centerline on fills.
2. Temporary berms shall be graded so as to drain to a compacted outlet at a slope drain. The area adjacent to the temporary berm in the vicinity of the slope drain must be properly graded to enable this inlet to function efficiently and with only minimum ponding in this area.
3. All transverse berms required on the downstream side of a slope drain shall extend across the grade to the highest point at approximately a ten (10) degree angle with a perpendicular to centerline. The top width of these berms may be wider and the side slope flatter on transverse berms to allow equipment to pass over these berms with minimal disruptions.
4. When practical and until final roadway elevations are approached, embankments should be constructed with a gradual slope to one side of the embankment to permit the placement of temporary berms and slope drains on only one side of the embankment.

B. Temporary Slope Drains

1. Temporary slope drains shall consist of stone gutters, fiber mats, plastic sheets, concrete or asphalt gutters, half round pipe, metal pipe, plastic pipe, flexible rubber, or other materials which can be used as temporary measures to carry water accumulating in the cuts and on the fills down the slopes prior to installation of permanent facilities or growth of adequate ground cover on the slopes.
2. Fiber matting and plastic sheeting shall not be used on slopes steeper than 4:1 except for short distances of 20 feet or less.
3. All temporary slope drains shall be adequately anchored to the slope to prevent disruption by the force of the water flowing in the drains. The base for temporary slope drains shall be compacted and formed to create a concave channel for the water or to hold the slope drain in place. The inlet end shall be properly constructed to channel water into the temporary slope drain. Energy dissipated will be accomplished at the discharge point using riprap or a small sediment basin which would slow the water as well as pick up some sediment. All temporary slope drains shall be removed when no longer necessary and the site restored to match the surroundings.

C. Sediment Structures

1. Sediment structures shall be utilized to control sediment at the foot of embankments where slope drains outlet; at the bottom as well as in the ditch lines atop waste sites; and in the ditch lines of borrow pits. Sediment structures may be used in most drainage situations to prevent excessive siltation of pipe structures. All sediment structures shall be at least four times as long as they are wide.
2. Dewatering structures shall be used to remove sediment from water pumped during dewatering operations. The dewatering structure must be sized to allow pumped

water to flow through the filtering device without overtopping the structure. Portable sediment tanks, straw bale/silt fence pits and sediment filter bags are types of dewatering structures recommended in the TDEC Erosion and Sediment Control Handbook.

3. When use of temporary sediment structures is to be discontinued, all sediment accumulation shall be removed, and all excavation backfilled and properly compacted. The existing ground shall be restored to its natural and intended condition.

D. Check Dams

1. Check dams shall be utilized to reduce the velocity of storm water in areas of concentrated flow, and to capture larger soil particles. Materials utilized to construct check dams are varied and should be clearly illustrated or explained in the Contractor's erosion control plan.
2. All check dams shall be keyed into the sides and bottom of the channel. A geotextile shall be set into soil to separate soil and rock.
3. The center of check dams should be at least 9-inches lower than either edge.
4. Check dam structures shall be designed and installed to prevent flooding of adjacent property, buildings and residences.

- E. Temporary Seeding and Mulching: Seeding and mulching shall be performed in accordance with the Section 02485. Seeding and mulching shall occur as soon as practical after final grade is achieved, but no later than 14 working days.

F. Baled Hay or Straw Erosion Checks

1. Hay or straw erosion checks shall be embedded in the ground four (4) to six (6) inches to prevent water flowing under them. The bales shall be installed turned upon the side of the bale. The bales shall also be anchored securely to the ground by wooden stakes driven through the bales into the ground. Bales can remain in place until they rot, or be removed after they have served their purpose, as determined by the Engineer. The Contractor shall keep the checks in good condition by replacing broken or damaged bales immediately after damage occurs. Normal debris cleanout will be considered routine maintenance.
2. Baled hay or straw checks can only be used in conjunction with silt fence or other approved methods as temporary control measures.

G. Temporary Silt Fences

1. Temporary silt fences shall be placed on the natural ground, at the bottom of fill or cut slopes, below soil stockpiles, or other areas where siltation is a problem. Silt fences are constructed of wire mesh fence with a covering of burlap or some other suitable material on the upper grade side of the fence and anchored into the soil. Temporary silt fence serves small drainage areas (maximum $\frac{1}{4}$ acre per 100 feet of silt fence length).
2. The Contractor shall be required to maintain the silt fence in a satisfactory condition for the duration of the project or until its removal is requested by the Engineer. The silt accumulation at the fence may be left in place and seeded or removed, as directed by the Engineer. The silt fence remains the property of the Contractor whenever the fence is removed.
3. Silt fences should not be installed across streams, ditches, waterways, or other concentrated flows. All silt fences should be installed along the contour, never up or

down a slope. The bottom 4 inches of the silt fence must be entrenched and backfilled to be effective.

3.05 MAINTENANCE AND REMOVAL

The temporary erosion prevention and sediment control features installed by the Contractor shall be satisfactorily maintained by the Contractor until no longer needed or permanent erosion control methods are installed. The Contractor shall be responsible for removing silt fences and check dams after the permanent cover is established. Any materials removed shall become the property of the Contractor.

3.06 EROSION CONTROL OUTSIDE PROJECT AREA

Temporary erosion prevention and sediment control shall include construction work outside the project area where such work is necessary as a result of construction such as borrow pit operations, haul roads, and equipment storage sites.

END OF SECTION

SECTION 02221

TRENCHING, BEDDING AND BACKFILLING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Excavation of all materials encountered in trench excavation, including earth, rock or other materials, whether wet or dry.
- B. Provide necessary sheeting, shoring and bracing.
- C. Dewater excavation as required.
- D. Undercut unsuitable materials and replace as required.
- E. Prepare a stable, satisfactory trench bottom.
- F. Place and compact granular beds, check dams, and backfill as appropriate.
- G. Dispose of any unsuitable or excess materials.

1.02 RELATED WORK

- A. Section 02110: Clearing and Grubbing
- B. Section 02200: Erosion Prevention and Sediment Control
- C. Section 02410: Cleanup and Restoration

1.03 PRECAUTIONS

- A. In accordance with the Tennessee State Law (Tennessee Underground Utility Damage Prevention Act), the Contractor shall properly notify underground utility owners prior to beginning excavation activities. Tennessee State Law requires notification to the statewide one-call center, Tennessee One-Call, at least three (3) working days prior to excavation, but not more than ten (10) working days in advance of beginning the work. Locate requests, including emergency locate requests, to Tennessee One-Call shall be processed in accordance with Tennessee State Law. Contact Tennessee One-Call at 811 or 1-800-351-1111 to process a locate ticket. The City of Clarksville will not locate its natural gas, water and sewer utilities without a locate ticket from Tennessee One-Call.
- B. Protect all structures, utilities, sidewalks, pavements, fences, vegetation and other features to remain.
- C. Protect all benchmarks, property pins, survey points and similar items. If disturbed or

damaged by construction operations, the Contractor shall pay the cost of restoration by a registered surveyor.

- D. Follow all Federal, State, County, TVA, TDOT, and Railroad regulations when working in Rights-of-Way not owned by City or in utility easement.
- E. Establish all erosion prevention and sediment control devices.
- F. Precautions shall be taken to eliminate tracking of soil, mud, rock and gravel onto streets and roadways.

1.04 DUST CONTROL

- A. When ordered by Engineer or his representative, furnish and distribute over traveled road surfaces which have not been fully restored an application of regular flake calcium chloride having a minimum calcium chloride content of 77 percent, or a brine solution consisting of 1.5 pound of calcium chloride and one pound of sodium chloride per 100 gallons of water applied by a pressure distributor. Rate of application shall be 3 pounds/square yard for the flake calcium chloride, and 0.48 gallon/square yard for brine solution.
- B. Whenever dust control is necessary, it shall be considered an integral part of the work, and no separate payment shall be made for it.

1.05 MAINTENANCE OF TRAFFIC AND CLOSING OF STREETS

- A. Carry on the work in a manner which will cause a minimum of interruption to traffic, and do not close to through travel more than two consecutive blocks, including the cross street intersected. Where traffic must cross open trenches, provide bridges at street intersections and driveways. Post signs indicating that a street is closed and necessary detour signs for the proper maintenance of traffic. Before closing any streets notify responsible municipal, state, county, emergency, transit and school system authorities.
- B. Place and maintain barricades, fences, construction signs, lights and flagmen as required during the progress of the construction work and until it is safe for traffic to use the roads and streets. The rules and regulations of OSHA, TDOT and other appropriate authorities respecting traffic safety provisions shall be observed.

PART 2 - PRODUCTS

2.01 BEDDING AND BACKFILL MATERIALS

- A. Class I Material: Angular, 1/4 to 1 inch graded stone.
- B. Class II Material: Coarse sands and gravels with a maximum particle dimension of 1-1/2 inch including variously graded sands and gravels containing small percentages of fines, generally

- granular and non-cohesive, either wet or dry.
- C. Class III Material: Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures.
- D. Class IV Material: Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits.
- E. In rock cuts, paved areas, roadways or other areas where free drainage bedding or backfill material is required, use Class I angular material.
- F. Flowable Fill: See requirements described in Section 02575, Part 2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Pre-construction photographs and video shall be taken by the Contractor, with special attention to improved areas, to aid in restoring landscaping and other items to their initial condition.
- B. Where controlled blasting is required for rock removal, the Contractor shall perform a pre-blast survey and have a blasting program prepared as specified in Paragraph 3.04 of this Section.
- C. Clear and grub as specified in Section 02110.
- D. Establish erosion prevention and sediment controls as specified in Section 02200.
- E. Protect all features to remain.
- F. Put in place all traffic and other safety provisions as required.

3.02 EXCAVATION

- A. Unless specifically shown otherwise on the Bid Form, all excavation is unclassified, and includes excavation to subgrade elevations regardless of the character of materials and obstructions encountered. It is to be understood that any reference to rock, earth or any other material on the drawings is not to be taken as an indication of classified excavation or the quantity of either rock, earth or any other material involved.
- B. The Bidder should make such investigations as deemed necessary to determine existing conditions and shall draw his own conclusions as to the conditions to be encountered. When rock borings, soundings or test pit data are provided, they are for information only and do not guarantee existing conditions.
- C. Align the trench as shown on the Contract Drawings. Deviations due to obstructions are

discussed in Paragraph 3.08 of this Section.

- D. Perform excavation in such a manner as to form a suitable trench in which to place the pipe and so as to cause the least inconvenience to the public.
- E. The Contractor shall be responsible for stripping, storing and protecting topsoil that is to be removed prior to excavation. This topsoil is to be reused during the cleanup and restoration. The Contractor is responsible for obtaining and providing other topsoil as may be necessary to restore the excavated area to its original topsoil quantity and quality.
- F. Pavement cuts shall be made along neat, straight lines with either a pavement breaker or pavement saw prior to the excavation. Cut pavement to be a minimum of 6 inches outside of trench cut. Coordinate all street cuts with the State, County and City Street Departments as applicable.
- G. Trenches shall be excavated to the depths indicated on the Contract Drawings. Trench depth shall be sufficient to provide a minimum cover of 36 inches over the top of the pipe in non-traffic areas and 48 inches in areas subject to vehicular traffic. Depth of cover is measured from finished grade to top of the pipe. Where approved by the Owner, additional pipe protection such as use of ductile iron pipe or concrete encasement may be used where minimum cover is not possible. Increased depth may be required as noted on the Contract Drawings to avoid obstructions, avoid requiring an air release valve and other reasons.
- H. Excavated material shall be placed a minimum of two feet back from the edge of the trench.
- I. When unstable soil or other unsuitable material is encountered at the trench bottom, undercut these materials to a depth required to assure support of the pipeline or as directed by the Engineer and backfill to the proper grade with compacted crushed stone. The top 6 inches shall be Class I angular material. Crushed stone for backfilling undercut unsuitable material will be a pay item under crushed stone for undercut replacement as set forth in Section 01026, Paragraph 3.04.
- J. Remove rock encountered in trench excavation to a minimum depth of 6 inches below the bottom of the pipe barrel, backfill with Class I angular material, and compact to uniformly support the pipe. In no case shall solid rock exist within six inches of the finished pipeline.
- K. Maximum width at the crown of the pipe shall be 2 feet plus the nominal diameter of the pipe, unless specifically approved otherwise by the Engineer due to unusual bracing and shoring requirements. Trenches constructed by mechanical trenching are allowed only with prior approval of Engineer. Over-excavation will be required at locations for fittings and valves and construction of concrete thrust blocks.
- L. Trenches 4 feet or more in depth should be provided with a means of egress. Spacing between ladders or other means of egress must be such that a worker will not have to travel more than 25 feet laterally to the nearest means of egress.
- M. Open excavations shall be barricaded when the Contractor is not at the site. At a minimum, this shall consist of orange polyethylene barricade safety fence. See Paragraph 1.05 of this section for additional requirements for excavations in traffic areas.

3.03 SHEETING, SHORING AND BRACING

- A. Furnish, put in place, and maintain such sheeting, shoring and bracing, as may be required to support the sides of the excavation and to prevent movement as required by OSHA. Damages resulting from improper shoring or failure to shore shall be the sole responsibility of the Contractor.
- B. Comply with all OSHA standards in determining where and in what manner sheeting, shoring and bracing are to be accomplished. The sheeting, shoring and bracing system shall be designed by a professional engineer licensed in the State of Tennessee and shall be subject to approval by the Engineer. However, such approval does not relieve the Contractor of the sole responsibility for the safety of all employees, the effectiveness of the system, and any damages or injuries resulting from the lack or inadequacy of the sheeting, shoring and bracing.
- C. The Contractor may use a trench box, which is a prefabricated movable trench shield composed of steel plates welded to a heavy steel frame. The trench box shall be designed to provide protection equal to or greater than that of an appropriate shoring system.
- D. Do not leave sheeting, shoring or bracing materials in place unless called for in the Contract Drawings, ordered by the Engineer, or deemed necessary or advisable for the safety or protection of new or existing work or features. Remove these materials in such a manner that the new structure or any existing structure or property, whether public or private, will not be endangered or damaged and that cave-ins and slides are avoided.

3.04 ROCK REMOVAL

- A. Controlled blasting may be used as an alternative to non-explosive methods of rock removal at the approval of the Owner. Controlled blasting shall be performed by a qualified explosive specialist, employed by the Contractor. The contractor shall have a Registration Certificate and each employee engaged in the blasting activity shall carry a valid identification card issued by the Division of Fire Prevention.
- B. All blasting shall be performed in accordance with the Tennessee Blasting Standards Act of 1975. Conduct all blasting operations in accordance with prevailing municipal, state or other agency regulations, codes, ordinances, or laws.
- C. The Contractor assumes all liability for all personal injury, any damage to real or personal property, or interference with the use or enjoyment of any property by reason of blasting or the resulting vibration or concussion. The Contractor assumes full responsibility for operating all equipment and performing all blasting in accordance with Federal and State laws, and regulations prescribed by any other Governmental authority limiting the amount of vibration or concussion.
- D. The Contractor shall prepare or retain a consultant to prepare the blasting program and to supervise and assist in monitoring the blasting. The blasting program shall include, but not be limited to, data on the locations, hole size, depth, over-depth, pattern and inclination of the blast holes, the type, strength, amount, distribution and powder factor for the explosives used, per hole and per blast, the sequence and pattern of delays, maximum amount of explosives in

any one period, depth of rock, and depth of overburden, if any, and the description and purpose of special methods to be used. This data shall be submitted to the Engineer upon request.

- E. The Contractor or his consultant shall conduct a pre-blast survey of the surrounding structures within 300 feet of any blasting operation and document their condition prior to any blasting. Documentation shall include written descriptions, videos and/or photographs of the structures, and measures of obvious signs of structural distress such as cracks. Gauge marks shall be located over existing cracks at selected locations to be measured before and after blasting to determine if widening or displacement has taken place.
- F. All blasts shall be designed to prevent fly rock. The Contractor shall use adequate, good quality stemming material and cover the blasts with blasting mats or an adequate soil cover.
- G. If structures or pipelines are damaged, promptly replace or repair them at no expense to Owner.
- H. Seismographic monitoring shall be done by the Contractor or his consultant and a record made of the peak particle velocities caused by the blasting. This data shall be included in the blasting report.
- I. Air blast shall be monitored with an approved instrument having the required frequency response and capable of providing a permanent record of the air blast effects. These records, identified by time and recording location shall be included in the blasting report.
- J. The Contractor shall maintain a daily log on ready inspection by the Engineer. A completed blasting report shall be submitted to the Engineer at the conclusion of all blasting.

3.05 DISPOSAL OF MATERIALS

- A. Whenever practicable, all materials removed by excavation that are suitable for backfilling pipe trenches or for other purposes shown on the drawings or directed by the Engineer shall be used for those purposes.
- B. Any materials not so used shall be considered waste materials and disposed of by the Contractor. Waste materials may be deposited in spoil areas at locations approved of by the Engineer, or shall be properly disposed of off-site if there is no approved spoil area.

3.06 UNAUTHORIZED EXCAVATION

- A. Unauthorized excavation is defined as all excavation outside or below the proposed lines and grades shown on the Contract Drawings or that which is directed by the Engineer.
- B. Backfill areas of unauthorized excavation with the type of material necessary to ensure the stability of the structure or construction involved.
- C. Unauthorized excavation and/or backfill to replace same shall not be a pay item.

3.07 DEWATERING

- A. The Contractor shall furnish, install and operate all necessary equipment to keep excavated areas free of water while work is in progress. Dewatering equipment shall be of adequate size and quantity to assure maintaining proper conditions for installing pipe, concrete, bedding, backfill or other material or structure in the excavation.
- B. Well-pointing shall be performed if required.
- C. Take particular precautions to prevent the displacement of structures or pipelines as a result of accumulated water. Any pipe displaced due to accumulated water shall be replaced by the Contractor at his expense.
- D. Dewatering operations shall be performed in a manner so as not to cause injury to public or private property or nuisance to the public nor contribute to pollution to surface water. The Contractor's dewatering operations shall be in full compliance with Section 02200 of these Specifications.

3.08 OBSTRUCTIONS

- A. Obstructions shown on the Contract Drawings are for information only and do not guarantee their exact locations nor that other obstructions are not present. The crossing of existing mains and services, which are approximately perpendicular to the proposed ditch line, is considered normal construction practice. The Contractor shall have the responsibility of making these crossings and repairing any damages to such crossings without additional reimbursement.
- B. Whenever unknown obstructions are encountered during the progress of the work that directly interfere with the vertical or horizontal alignment of the pipeline, the Engineer shall have the authority to order a deviation from the grade or alignment or for the removal, relocation or reconstruction of the obstructing utility or structure. Likewise, the Contractor may request to relocate the proposed line or request reimbursement for relocating the existing line or performing unusual shoring beyond what is normally required for trench stabilization.
- C. When utilities or obstructions are not shown on the Contract Drawings but are present off the roadway at the location of the proposed pipeline route, the Contractor may request to relocate the pipeline in the roadway if necessary to avoid disturbing the utility or obstructions. If the relocation is approved by the Engineer into a paved area, the Contractor shall receive compensation for additional granular backfill and pavement replacement as measured and paid for as set forth in Section 01026, Paragraph 3.07.
- D. Exercise due care in excavating adjacent to existing obstructions and do not disturb same unless absolutely necessary.
- E. In the event existing utilities are disturbed, repair or replace as quickly as possible to the condition existing prior to their disturbance at no cost to the Owner. If required by the Owner, pay for the repair or replacement work performed by the forces of the utility company or other appropriate party.
- F. If replacement or repair of disturbed obstructions is not performed after a reasonable period

of time, the Owner may have the necessary work done and deduct the cost of same from payments to the Contractor.

3.09 BEDDING OF GRAVITY SEWER MAINS

- A. Always maintain proper grade and alignment during the bedding and tamping process. Any pipe damaged or displaced during this process shall be replaced by the Contractor at his expense.
- B. Provide a minimum of 6 inches of compacted Class I angular material for bedding of all gravity sanitary sewer pipe regardless of pipe material. Dig bell holes so that the barrel of the pipe will rest for its entire length upon the prepared bedding to assure uniform support of the pipe.
- C. Completely encapsulate each PVC sewer pipe section with a minimum of 6 inches of Class I angular material on the top, both sides and the bottom of the pipe.
- D. Where gravity sewer pipe, regardless of pipe material, is laid within a rock cut, completely encapsulate each pipe section with a minimum of 6 inches of Class I angular material on the top, both sides and the bottom of the pipe.

3.10 BEDDING OF WATER MAINS AND SEWER FORCE MAINS

- A. Water mains and sewer force mains may be laid on a stable earth bed in a trench cut in natural ground. Excavate the trench in such a manner as to form a suitable bed on which to place the pipe. Where unstable soil or other unsuitable material is encountered at the trench bottom, undercut and replace these materials as discussed in Paragraph 3.02 of this Section.
- B. Where water lines and sewer force mains are laid within a rock cut, completely encapsulate each pipe section with a minimum of 6 inches of Class I angular material on the top, both sides and the bottom of the pipe.
- C. Dig bell holes so that the barrel of the pipe will rest for its entire length upon the natural earth trench bed or prepared bedding to assure uniform support of the pipe.

3.11 INITIAL BACKFILLING

- A. Do not begin backfilling before the Engineer or his representative has inspected or approved the grade and alignment of the pipe, the bedding of the pipe, and the joints between the pipes. If backfill material is placed over the pipe before an inspection is made, the Engineer or his representative may require the Contractor to reopen the trench in order for an inspection to be made at no cost to the Owner.
- B. Perform initial backfilling by hand or by carefully dumping small quantities of fill from a loader bucket, until fill has progressed to 6 inches above the top of the pipe.

3.12 FINAL BACKFILLING

- A. Final backfilling shall be performed as soon as practicable after inspection and initial backfilling is complete. Adequate precautions shall be taken to insure proper placement and compaction

of backfill without disturbing or damaging pipe. Fill shall be properly compacted and suitable precautions shall be taken to insure permanent stability for pipe. Utilities shall be provided with adequate cover or additional protection as described in Paragraph 3.02 of this Section.

B. Backfilling in unimproved areas:

1. Dispose of all soft, yielding or organic material that is unsuitable for trench backfill and replace with suitable material. The maximum dimension of individual stones and broken rock within the backfill should not exceed 6 inches.
2. Deposit, spread and compact backfill in even layers no greater than 12 inches deep to the surface with suitable equipment in such a manner so as not to disturb the pipe. If earth material for backfill is, in the opinion of the Engineer or his representative, too dry to allow thorough compaction, the Contractor shall add enough water so that the backfill can be properly compacted.
3. Neatly round sufficient surplus excavated material over the trench to compensate for settlement of the backfill.
4. The top 12 inches of backfill material shall consist of fine loose earth free from large clods, vegetable matter, debris, stone and/or other objectionable materials.
5. Properly dispose of all excess excavated material.
6. Prior to final acceptance, finish grade, restore topsoil and reestablish landscaping as specified in Sections 02410 and 02485.

C. Backfilling beneath flexible and rigid pavements:

1. Use Class I angular material of either crushed limestone or crushed gravel of high weight and density.
2. Carefully deposit in uniform layers, not to exceed 6 inches thick.
3. Compact each layer thoroughly by rolling, ramming and tamping with tools suitable for that purpose in such a manner so as not to disturb the pipe.
4. Flowable fill may be used at the Contractor's request with approval of the Engineer, when specified on a particular project, or when required by the Clarksville Street Department. Payment for flowable backfill will be included as a separate pay item.

D. Backfilling of shoulders along streets and highways:

1. Backfilling methods and materials for shoulders along streets and highways shall be in accordance with the requirements of governing State, County or City departments maintaining the particular roadway or highway.
2. Replace with similar materials, all shoulders that may be damaged or destroyed as a result of pipe trenching.
3. Backfilling of shoulders shall not be directly measured for payment.
4. Where shoulders along state highways have seal coat surfaces, replace with double bituminous seal in accordance with TDOT requirements.
5. Where TDOT or local authority requires trenches to be backfilled entirely with granular material in the shoulder of roads, granular material so placed shall not be a pay item, but included in the prices per linear foot of pipe unless provided for specifically on the Bid Form.
6. Backfill in state highways may also be performed utilizing flowable fill. Refer to Section 02575, Paragraph 3.08 for installation requirements.

E. Crushed stone for pavement and shoulder replacement:

1. Where possible, salvage and reuse all base material that is removed during

- construction.
2. Wet and thoroughly compact crushed stone and blade to tie into the existing surface prior to final acceptance.
 3. Base material placed as a portion of pavement replacing items will not be measured for payment.

3.13 CHECK DAMS

- A. Check dams shall be installed in the bedding and backfill of new or replaced gravity sewer lines to limit the drainage area subject to the French drain effect of gravel bedding. Major rehabilitation projects should also include check dams in the design.
- B. Check dams shall consist of compacted clay bedding and backfill at least three (3) feet thick to the top of the trench and cut into the walls of the trench two (2) feet. Alternatively, concrete may be used, keyed into the trench walls.
- C. Check dam material within one foot of the sewer main shall be carefully hand placed and compacted. No gravel backfill or bedding shall be used in the check dam area.
- D. Check dams shall be installed upstream of each manhole.
- E. All stream crossings shall include concrete check dams on both sides of the crossing.

END OF SECTION

CLEANUP AND RESTORATION

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Work included in this section consists of finish grading, site cleanup, patching of pavement, repairing and/or reinstalling all public and private improvements disturbed by the construction.
- B. Cleanup shall follow in close succession to other construction activities and shall be a daily function. Allowances will be made for time of settling of backfilled trenches before final grading and landscaping is attempted; however, drainage ditches are not to be left obstructed. The concept of leaving cleanup until the other construction is completed is not acceptable.
- C. The City reserves the right to withhold payments (in part or in whole) if cleanup and restoration does not meet with the approval of the City.

1.02 RELATED WORK

- A. Section 02200: Erosion Prevention and Sediment Control
- B. Section 02575: Pavement Repair
- C. Section 02485: Lawn and Grass Landscaping

PART 2 - PRODUCTS

All materials and products used for repair and/or replacement of disturbed areas shall meet or exceed the type and quality of the original.

PART 3 - EXECUTION

3.01 PRE-CONSTRUCTION PHOTOGRAPHS

The Contractor shall use the photographs and/or video taken prior to construction to aid in cleanup and restoring landscaping and other features, public or private, to their original condition or better.

3.02 FINISH GRADING AND TOPSOIL RESTORATION

- A. After allowing backfill adequate time to settle, finish grade all areas to produce a uniform, satisfactory finish with rounded surfaces at the top and bottom of abrupt changes in grade.
- B. Refill areas where noticeable settlement has occurred.
- C. Finish grading shall be performed such that the area will drain satisfactorily and will not hold or collect standing water.
- D. Restore topsoil as specified in Section 02485, Paragraph 3.02.
- E. Dress for final inspection such that the surface is free of large clods, debris, stone and/or other objectionable material.
- F. Restore lawn and grass landscaping in accordance with Section 02485. Final stabilization by lawn and grass landscaping shall occur within 14 days of completion of finish grading to begin establishment of ground cover to prevent erosion.

3.03 PAVEMENT MAINTENANCE AND REPLACEMENT

- A. All excavation in traffic areas, whether bituminous, concrete, or gravel, shall be backfilled with compacted crushed stone. The stone shall be brought to the grade of the surrounding pavement to provide a temporary surface for traffic. The Contractor is responsible for grading and maintaining the gravel surface until the final pavement is in place.
- B. Throughout the duration of the project, pavements shall be kept free of mud, gravel and other construction debris to avoid unnecessary tracking of mud and spreading of dust. If conditions warrant, the Contractor shall be responsible for arranging for street washing to remove unnecessary amounts of mud from the pavement and also to control dust. This will not be a pay item but will be a responsibility of the Contractor when conditions warrant.
- C. Damaged pavement, whether concrete or asphalt, shall be properly replaced with the corresponding same equal material. In some cases the City Street Department will assume the responsibility for the final paving after the Contractor has properly cut, trimmed and backfilled the utility trench. The Contractor shall assume the total responsibility for repaving unless stated specifically otherwise in the Contract Documents. Pavement repair shall be in accordance with Section 02575.

3.04 CURBS, SIDEWALKS, STEPS, ETC.

- A. All curbs, sidewalks, steps, etc. which are damaged or disturbed shall be replaced by squarely cutting or removing at the nearest sound joint or section and re-pouring the new structure to match or exceed the quality and appearance of the original.
- B. All repairs shall be compliant with the City Street Department and the Americans with Disabilities Act (ADA). Any new curbs, sidewalks, steps, etc shall be designed and installed to meet requirements of the ADA.

3.05 FENCES

All fences and posts, which are damaged or removed, shall be re-erected. Posts shall be firmly set and tamped. Wire fences shall be tightly stretched. New materials shall be used when it is obvious that the existing material cannot be reinstalled to its condition prior to being disturbed.

3.06 SHRUBS, FLOWERS AND ORNAMENTALS

Where noted on the plans or as directed by the City, all attempts shall be made to protect, preserve and reset shrubs, flowers and ornamentals disturbed by the construction.

3.07 MAILBOXES, ETC.

- A. Mailboxes that are disturbed by the construction shall be reinstalled or relocated immediately in a serviceable condition and location. After backfilling and re-grading, the mailbox shall be permanently and properly erected.
- B. All other public or private improvements disturbed by the construction shall be repaired or replaced to original condition unless specifically exempted in the Contract Documents.

3.08 EROSION AND SEDIMENT CONTROL

- A. The Contractor shall maintain all areas where excavating and backfilling operations are being performed or have been performed in order that siltation and bank erosion will be kept to a minimum during construction. This requirement includes construction of temporary erosion barriers and use of special methods to control erosion.
- B. The Contractor shall be responsible for removing all temporary erosion protection and sediment control devices, including silt fences and check dams, after the permanent cover is established.

END OF SECTION

LAWN AND GRASS LANDSCAPING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. All activities necessary to restore areas disturbed by construction, or other designated areas, to their original landscaped condition and quality.
- B. Preparation of landscape area including loosening, pulverizing and fertilizing.
- C. Placement of seed, sprigging, sod and topsoil including mulch, where required.
- D. Watering of landscaping.

1.02 RELATED WORK

- A. Section 02110: Clearing and Grubbing
- B. Section 02200: Erosion Prevention and Sediment Control
- C. Section 02410: Cleanup and Restoration

PART 2 - PRODUCTS

2.01 SEED MATERIALS

- A. Inspect and test seed for germination and purity prior to mixing.
- B. Uniformly mix by Group:

<u>Seed Name</u>	<u>Quantity % by Weight</u>
GROUP "A"	
Lespedeza (common or Korean)	20%
Sericea Lespedeza	15%
Kentucky 31 Fescue	40%
English Rye	25%
GROUP "B"	
Kentucky 31 Fescue	55%
Redtop	15%

English Rye 30%

GROUP "C"

Sericea Lespedeza 50%

Kentucky 31 Fescue 30%

English Rye 20%

- C. Use Group "A" seed from February 1 to August 1.
- D. Use Group "B" seed from August 1 to December 1, with the exception that either Group "A" or "B" may be used during the month of August.
- E. Use Group "C" seed from December 1 to February 1, but only when specified on the Contract Drawings or otherwise approved.
- F. All seed shall meet the requirements of the Tennessee Department of Agriculture.
- G. Upon request, furnish the Engineer a certified laboratory report showing the analysis of the seed to be furnished. The report shall bear the signature of a senior seed technologist.
- H. Inoculant for Legumes:
 - 1. Nitrogen fixing bacteria cultures adapted to the particular seed to be treated.
 - 2. Furnish in containers of a size sufficient to treat the specified quantity of seed to be planted.

2.02 MULCH MATERIALS

- A. Hay composed of approved stalks from grasses, sedges or legumes; or straw composed of stalks from rye, oats, wheat, or other approved grains.
- B. Air dried and reasonably free from noxious weeds, weed seeds, and other detrimental plant growth.
- C. Suitable for spreading with mulch blower machinery.
- D. Wood fiber mulch, when used, shall meet the following specifications:
 - Moisture Content 10.0 % ± 2.0%
 - Organic Matter 99.4 % ± 0.2%
 - Ash Content 0.6 % ± 0.2%
 - Water Hold Capacity (per hundred ... 1050 grams minimum grams of oven dry fiber)
- E. Mulch Binders:
 - 1. Cut back asphalt, Grade RC-70 or RC-250 conforming to AASHTO M-8I, M-82, M-14I, for the type and grade specified.
 - 2. Emulsified asphalt, Type SS-I conforming to AASHTO M-140. In addition to Type SS-1, a special mixing material AE-3 or a special priming material AE-P may be specified.

2.03 JUTE MESH

- A. Open plain weave of single jute yarn or photodegradable straw-filled mesh blankets and non-toxic to vegetation.
- B. Tag jute rolls for identification with 58 warp ends per yard, 41 weft ends per yard and weighing approximately 0.9 pounds per square yard with an acceptable tolerance of 5 percent.

2.04 STAPLES

New and unused, machine-made of No. 11 gauge steel wire formed into a "U" shape.

2.05 SOD MATERIALS

- A. Live, dense, well-rooted growth of permanent grasses, free from Johnson grass, nutgrass, and other undesirable grasses or weeds and well-suited for the proposed application to particular soils.
- B. Cleanly cut in strips having a reasonably uniform thickness of not less than 2-1/2 inches, a uniform width of approximately 8 inches, and a minimum length of 12 inches.

2.06 COMMERCIAL FERTILIZERS

- A. Unless otherwise specified, inorganic 10-10-10 nitrogen, phosphoric acid, and potash for seeding and 15-15-15 or 10-10-10 for sodding.
- B. Furnish in standard containers with the brand name, weight and guaranteed analysis of the contents clearly marked.
- C. Comply with Federal, State, and local laws.
- D. Ammonium Nitrate shall be a standard commercial product, having a minimum of 33.5 percent nitrogen.
- E. Agricultural limestone shall contain a minimum of 85% of calcium carbonate and magnesium carbonate combined, and be of particular size that 85% will pass a No. 10 mesh sieve.

2.07 WATER

Ensure that water is free of harmful organisms or other objectionable materials.

2.08 TOPSOIL

- A. Natural, friable, fertile, fine sandy loam possessing characteristics of representative top soils in the vicinity, which produce heavy growths of vegetation.
- B. Free from subsoil, noxious weeds, stones larger than one inch in diameter, lime, cement, ashes, slag, or other deleterious matter.

- C. Well drained in its original position and free from toxic quantities of acid or alkaline elements.

PART 3 - EXECUTION

3.01 GENERAL

- A. All unpaved or non-graveled areas disturbed by the construction of project or any other areas as specified shall have a stand of grass developed by one of the following methods: Seeding will generally be acceptable; however, if repeated seeding fails due to continued erosion or other unsatisfactory conditions, sprigging or sodding shall be used. If the imported topsoil or seeds result in Johnson grass or other undesirable weeds, the Contractor shall eliminate this growth with herbicides and reestablish an acceptable growth.
- B. Before beginning seeding, sprigging or sodding operations in any area, complete finish grading and restoration of topsoil and have work approved by the Engineer or his representative.

3.02 TOPSOIL

- A. The Contractor shall save and stockpile the topsoil removed from the excavation area or otherwise obtain topsoil to restore the area and reestablish an acceptable stand of grass.
- B. Prepare landscape area to receive topsoil in close conformity to the lines and grades shown on the drawings.
- C. Place topsoil at depths and locations shown on the drawings. Otherwise, topsoil shall be restored to its original quantity and quality, but no less than necessary to establish and promote an acceptable stand of grass.

3.03 SEEDING

- A. Scarify, disc, harrow, rake or otherwise work each area to be seeded until it has been loosened and pulverized to a depth as directed by the Engineer.
- B. Uniformly incorporate fertilizer into the soil to a depth of approximately 1/2" at the rate of:
 - 1. Not less than 40 lbs. per 1000 square feet for grade 10-10-10 or equivalent.
 - 2. Not less than 100 lbs. per 1000 square feet for agricultural limestone.
- C. Fertilizer need not be incorporated in the soil as specified above when mixed with seed in water and applied with power sprayer equipment.
- D. Sow seed of the specified group as soon as preparation of the seedbed has been completed.
- E. Sow uniformly by means of a rotary seeder, hydraulic equipment, or other satisfactory means at the rate of 1½ pounds per 1000 square feet, unless otherwise specified.

- F. Inoculate Group "C" seed and seeds of legumes, when sown alone, before sowing in accordance with the recommendations of the manufacturer of the inoculant.
- G. Do not perform seeding during windy weather, or when the ground surface is frozen, wet or otherwise non-tillable. No seeding shall be performed during December through February unless otherwise permitted by Engineer.
- H. When specified, provide seeding with mulch:
 - 1. Spread hay or straw mulch evenly over the seeded area at an approximate rate of 75 pounds per 1000 square feet immediately following the seeding operations. This rate may be varied by the Engineer depending on the texture and condition of the mulch material and the characteristics of the area seeded.
 - 2. Hold hay or straw mulch in place by the use of a mulch binder applied at the approximate rate of 4 gallons per 1000 square feet as required.
 - 3. Cover bridges, 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.
 - 4. When wood fiber mulch is used, uniformly apply at the rate of 28 to 35 pounds per 1000 square feet with hydraulic mulching equipment.

3.04 SPRIGGING

- A. Lightly incorporate fertilizer into the soil to a depth of approximately 1/2" at the rate of:
 - 1. 15 lbs. per 1000 square feet for grade 0-20-20 or equivalent.
 - 2. 40 lbs. per 1000 square feet for agricultural limestone.
- B. Perform sprigging during September-November or April-May and only when the soil is in tillable or workable condition.
- C. Do not set crowns during windy weather or when the ground surface is frozen.
- D. Set crowns as soon as preparation of the sprig bed has been completed.
- E. Set crowns at the rate of three sprigs per square yard by means of a tree-planting bar or equal.
- F. When specified, perform mulching before sprigging:
 - 1. Spread mulch material evenly over the area to be planted at the rate of 100 lbs. per 1000 square feet. This rate may be varied by the Engineer depending upon the texture and condition of the mulch material and the ground surface.
 - 2. Cover with a uniform layer of mulch so that 20 to 25 percent of the ground is visible. The mulch shall be loose enough to allow sunlight to penetrate and air to circulate slowly, but thick enough to partially shade the ground and to reduce erosion.
 - 3. Hold the mulch in place with mulch binders applied at the rate directed by the Engineer, not to exceed 0.1 gallon per square yard, as required to hold the mulch in place.

3.05 SODDING

- A. Place sod at all locations shown on the Contract Drawings or where directed.

- B. Loosen the surface of the ground to be sodded to a depth of not less than one inch with a rake or other device.
- C. If necessary, sprinkle with water until saturated for a minimum depth of one inch and keep moist until the sod is placed.
- D. Immediately before placing the sod, fertilize the prepared surface uniformly at the rate of:
 - 1. 12 lbs. per 1000 square feet for grade 10-10-10 or equivalent.
 - 2. 100 lbs. per 1000 square feet for agricultural limestone.
- E. Place sod as soon as practical after removal from the point of origin, and keep in a moist condition during the interim.
- F. Carefully place, by hand, on the prepared ground surface with the edges in closed contact and, as far as possible, in a position to break joints.
- G. Each strip of sod laid shall be fitted and pounded into place using 10 inch wood tramps, or other satisfactory implements.
- H. Immediately after placing, thoroughly wet and roll with an approved roller or hand-tamp as approved by the Engineer.
- I. On slopes of two to one (2:1) or steeper, pinning or pegging may be required to hold the sod in place.

END OF SECTION

PAVEMENT REPAIR

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The work specified by this section shall consist of repairing or replacing all damaged pavement, whether public or private. Dirt shoulders, roads, streets, drives, and walks shall be restored to their original condition as an incidental part of the installation of utilities. Repair damaged base on either side of a trench wherever necessary. Trim the pavement surface to neat lines outside of the trench wall, and repave the entire area as specified below and as shown on the drawings or on the standard details.
- B. These specifications make reference to the current edition of the standard specifications of the Tennessee Department of Transportation (TDOT). Even though the weather limitations, construction methods, and materials specifications contained in the TDOT specifications may not be explicitly repeated in these specifications, they shall, wherever applicable to the work called for by this section, be considered as implied and therefore adhered to. However, the various subsections "Basis for Payment" contained in the TDOT specifications shall not be considered applicable.
- C. All pavement repair work shall be in compliance with the requirements of the State, County or Clarksville Street Department.

1.02 RELATED WORK

Section 02410: Cleanup and Restoration

PART 2 - PRODUCTS

Pavement materials shall conform to TDOT specifications as listed below.

- 2.01 MINERAL AGGREGATE BASE: Class A, Grading D crushed stone (TDOT specifications, Section 303, subsection 903.05).
- 2.02 BITUMINOUS PRIME COATS: Cutback asphalt, Grade RC-250, or emulsified asphalt, Grade AE-P (Section 402, subsections 904.02 and 904.03).
- 2.03 CRUSHED STONE CHIPS: Size 6 or Size 7 (Subsection 903.14)
- 2.04 DOUBLE BITUMINOUS SURFACE: For both courses, either cutback asphalt, Grade RC-800, or RC-3000, or emulsified asphalt, Grade RS-2 (Subsections 904.02 or 904.03).

- 2.05 ASPHALTIC CONCRETE BINDER: Grading B or C, as directed by the Engineer (Section 307).
- 2.06 BITUMINOUS TACK COAT: Grade AE-3 (Section 403, Subsection 904.03).
- 2.07 ASPHALTIC CONCRETE SURFACE: Grading E (Section 411).
- 2.08 QUICK DRY TRAFFIC MARKING PAINT (WHITE AND YELLOW): Subsection 910.05.
- 2.09 FLOWABLE FILL
 - A. Portland Cement: Section 901.01
 - B. Fine Aggregate: Section 903.01
 - C. Fly Ash, Type C or F: AASHTO M295
 - D. Water: Section 918.01
 - E. Chemical Additives: Section 918.09
 - F. Air Entraining Mixtures: Section 918.09

PART 3 - EXECUTION

3.01 GENERAL

All paving shall be completed using appropriate equipment and machinery. All work must be coordinated with and approved by the City or County Street Department, TDOT or other governing authority. The Contractor shall perform all work in accordance with the governing authority and shall make all repairs as directed by that authority at no expense to the Owner.

3.02 SUBGRADE

- A. Before any base material is installed, compact the sub-grade of the area to be paved to 95% of optimum density as determined by ASTM D698 (Standard Proctor).
- B. The backfill material shall contain no topsoil or organic matter. For all areas where sub-grade has been prepared, test for uniformity of support by driving a loaded dump truck at a speed of two (2) to three (3) miles per hour over the entire surface. Make further improvements on all areas that show a deflection of one (1) inch or more. When completed, the finished sub-grade shall be hard, smooth, stable, and constructed in reasonably close conformance with the lines and grades that existed prior to beginning construction.
- C. When a base course is compacted, cut back the surface course of the existing pavement a minimum of one (1) foot beyond the limit of the joint between the old and new base course or

as shown on the standard drawings. Take special care to ensure good compaction of the new base course at the joint. Apply and compact the surface to conform to the existing pavement so that it will have no surface irregularity.

- D. No separate payment shall be allowed for sub-grade preparation. Cost for sub-grade preparation shall be included in the applicable pay item for the proposed work related to pavement replacement.

3.03 BASE

- A. Install a mineral aggregate base of the type specified above in accordance with Section 303 of the TDOT specifications. The maximum compacted thickness of any one layer shall be six (6) inches and total thickness of the base shall be that indicated by the standard drawings or as shown on the Contract Drawings.
- B. No separate payment shall be allowed for base stone. Costs for additional make-up base stone shall be included in the pavement replacement unit prices.

3.04 SEAL COAT SURFACE

Uniformly apply a bituminous prime coat of emulsified asphalt, Grade AE-P, or cutback asphalt, Grade RC-250, over the entire width of the area to be surfaced at a rate of 0.3 gallon per square yard. Immediately after application, uniformly cover the entire area with Size 7 crushed stone chips at a rate of 12 pounds per square yard.

3.05 DOUBLE BITUMINOUS SURFACE

- A. Apply the first course at a rate of 0.38 to 0.42 gallon per square yard with emulsified asphalt, Grade RS-2, or cutback asphalt, Grade RC-800 or RC-3000, and then immediately cover the Size 6 crushed stone chips at a rate of 33 to 37 pounds per square yard. After this is rolled, apply the second course at a rate of 0.30 to 0.35 gallon per square yard, and at once uniformly cover the Size 7 chips at a rate of 20 to 25 pounds per square yard. Then roll the entire area.
- B. After the application of the cover aggregate, lightly broom or otherwise maintain the surface for a period of four (4) days, or as directed by the Engineer. Maintenance of the surface shall include the distribution of cover aggregate over the surface to absorb any free bitumen and cover any areas deficient in aggregate. Sweep excess material from the entire surface with rotary brooms. Sweep the surface at the time determined by the Engineer.

3.06 ASPHALTIC CONCRETE BINDER

- A. Apply a bituminous prime coat of emulsified asphalt, Grade AE-P, or cutback asphalt, Grade RC-250, at a rate of 0.38 to 0.42 gallon per square yard. Take care to prevent the bituminous material splashing on exposed faces of curbs and gutters, walls, walks, trees, etc.; if such splashing does occur, remove it immediately. After the prime coat has been properly cured, apply an asphaltic concrete binder to the thickness shown on the standard drawings or the Contract Drawings.

- B. Carefully place the material to avoid segregation of the mix. Broadcasting of the material will not be permitted. Remove any lumps that do not readily break down.

3.07 ASPHALTIC CONCRETE SURFACE

- A. If the asphaltic concrete surface course is to be placed directly on the mineral aggregate base, place a bituminous prime coat as described above. If, however, the surface course is to be placed on a binder course, then apply a bituminous tack coat of the sort specified above under PRODUCTS at a rate of 0.05 to 0.10 gallon per square yard.
- B. Take care to prevent the bituminous material splashing on exposed faces of curbs, gutters, walls, walks, trees, etc.; if such splashing does occur, remove it immediately. After the prime or tack coat has been properly cured, apply the asphaltic concrete to the thickness shown of the drawings or standard drawings. Apply the surface course as described above for the binder course.

3.08 FLOWABLE FILL

- A. Flowable fill shall be used where designated on the Contract Drawings and on any crossing of a State Highway or as required by City Street Department or the County Highway Department.
- B. Flowable fill shall be covered or otherwise protected while in the flowable state. No embankment or fill shall be placed on the flowable fill prior to final set or hardening as determined by the Engineer.
- C. All sections of pipe shall be securely braced or anchored both horizontally and vertically, if necessary, to prevent movement of the pipe during placement of the flowable fill. Pipe sections shall be joined so as to prevent the influx of flowable fill around the joints. The Contractor shall replace at his expense any pipe or sections of pipe which do not conform to the above requirements.
- D. Flowable fill shall be proportioned as follows:
 - 1. Portland Cement Type 1, 100 lbs./c.y.
 - 2. Fly Ash, 250 lbs. (minimum)/c.y.
 - 3. Fine Aggregate, 2,800 lbs./c.y.
 - 4. Water, 60 gal/c.y.
 - 5. Proportions may be adjusted by the Engineer to achieve a consistency for satisfactory flow.

3.09 SMOOTHNESS

The finished surfaces shall conform to the lines and grades that existed prior to construction. No deviations, variations, or irregularities exceeding 1/4 inch in any direction when tested with a 12-foot straightedge shall be permitted in the finished work, nor will any depressions that will not drain. Correct all such defects.

3.10 SAMPLING AND TESTING

- A. Submit to the Engineer test reports made by an independent testing laboratory on the crushed stone aggregate, bituminous materials, and asphaltic concrete design mixes, and obtain his approval of these reports before starting paving operations.
- B. Tests shall be made of the completed elements of the pavement to ascertain the compacted thickness of the base and surface courses. If sections with deficient thicknesses are found, the full section for a reasonable distance on each side of the deficiency shall be refused. Remove and reinstall all such sections. Patch all test holes in connection with thickness test.
- C. When making surface tests, furnish one (1) man to mark all surface defects for corrections.

3.11 PAVEMENT STRIPING

All disturbed pavement markings including stop bars shall be replaced to match existing striping.

END OF SECTION

WATER DISTRIBUTION SYSTEMS

PART 1 – GENERAL

1.01 WORK INCLUDED

Installation, testing, and disinfection of water lines and appurtenances.

1.02 RELATED WORK

- A. Section 02221: Trenching, Bedding and Backfilling
- B. Section 02715: Fire Service Water Meters

PART 2 – MATERIALS, STORAGE AND HANDLING

2.01 MANUFACTURER’S RECOMMENDATION

Care shall be exercised in the delivery, storage and handling of all materials prior to their incorporation into the work. Follow all manufacturers’ recommendations for delivery and storage (except where these specifications differ.) Acceptance of questionable material shall be based solely on the Engineer’s interpretation of fabrication, delivery, storage and installation practices of the material in question.

2.02 STORED PIPE

Contractor shall take special care to assure that no foreign matter including, but not limited to, soil, trash, trench water or other debris enters the pipe at any time. Upon arrival of pipe shipment, Contractor shall completely seal pipe openings in a manner acceptable to the Engineer.

2.03 STORED FITTINGS

Contractor shall take special care to assure that no foreign matter including, but not limited to soil, trash, trench water or other debris enters pipe appurtenances at any time. Upon arrival of pipe shipment, Contractor shall completely seal pipe openings in a manner acceptable to the Engineer.

2.04 INSTALLED PIPE

The installed pipe in the trench shall be plugged at the close of work each day or during any prolonged break period, including anytime workers are absent from the jobsite (lunch breaks, etc.). The only acceptable method for plugging the installed pipe is with a watertight M.J. cap or M.J. plug.

2.05 FAILURE TO FOLLOW SPECIFICATIONS

Failure to take such preventative measures mentioned in these specifications, or flooding or contamination of the main for any reason, shall require the Contractor to clean the line with a hydraulically propelled foam pig (or other suitable pigging device acceptable to the City Engineer) and slug chlorinate the line as specified in Paragraph 4.08 of this Section. The Contractor shall also be required to take whatever other measures required by the City Engineer in accordance with these specifications or AWWA C-651 to remove the contamination. All such procedures shall be fully documented and submitted for approval by the City Engineer.

PART 3 – PRODUCTS

3.01 POLYVINYL CHLORIDE PIPE (PVC) AND FITTINGS

- A. Provide PVC pipe meeting ASTM D02241 or AWWA C900.
- B. ASTM D02241 Pipe:
 - 1. Manufactured from virgin, National Sanitation Foundation (NSF) approved Type 1, Grade 1 impact improved resin suitable for use in transporting potable water.
 - 2. Pipe and fittings pressure rated for 200 psi.
 - 3. Use only where the maximum pressure shall not exceed 90 psi.
 - 4. Maximum Standard Dimensional Ratio (SDR) of 21.
 - 5. Joints sealed with a rubber ring and non-toxic lubricant as provided by the manufacturer meeting or exceeding the requirements of ASTM D3139 and ASTM F477.
 - 6. Clearly mark with the manufacturer's name, nominal diameter, SDR, ASTM D02241, pressure rating, and NSF approval seal.
 - 7. Furnish in standard laying lengths of twenty (20) feet.
 - 8. Color of pipe shall be blue or white.
- C. AWWA C-900 Pipe:
 - 1. PVC 1120 pipe manufactured from virgin, National Sanitation Foundation (NSF) approved compounds meeting the requirements of ASTM D1784.
 - 2. Pipe and fittings pressure rated for 200 psi.
 - 3. Outside diameter equivalent to the same outside diameter of cast iron pipe.
 - 4. The minimum wall thickness of the bell, at any point, shall conform to the DR requirements of the pipe.
 - 5. Furnish in standard laying lengths of twenty (20) feet.
 - 6. Clearly mark with the manufacturer's name, nominal diameter, DR, PVC 1120, pressure class, AWWA C900, and NSF approval seal.
 - 7. Color of pipe shall be blue or white.
 - 8. To be used in areas where service pressure exceeds 90 psi.
- D. PVC Fittings: Not allowed for water mains.

3.02 DUCTILE IRON PIPE AND FITTINGS

- A. Pipe:
1. All pipe 10-inch and larger shall be ductile iron.
 2. Manufactured in accordance with ANSI A21.51 (AWWA C151).
 3. A cement lining meeting the requirements of ASNI 21.4 (AWWA C104).
 4. A minimum of 1 mil thick bituminous coating on the outside surface.
 5. Clearly mark with manufacturer's name, D.I. or Ductile, weight, class or nominal thickness, and casting period.
 6. Unless otherwise specified or shown on the plans, ductile iron pipe shall be pressure class 350 for sizes up through 12-inch. Sizes 14-inch and larger shall be class 250.
 7. For directional bores, restrained joint ductile iron pipe equivalent to American Flex Ring or U.S. Pipe T.R. Flex with minimum pressure class 350 shall be used.
- B. Fittings: All fittings and specials for pipe 3" in diameter and larger shall be cast or ductile iron.
1. Fittings 3" – 24": Pressure rated at 350 psi meeting the requirements of ANSI 21-53/AWWA C153 for compact fittings.
 2. Fittings 30" – 36": Pressure rated at 250 psi meeting the requirements of ANSI 21.10/AWWA C110 for full size fittings or ANSI 21.53/AWWA C153 for compact size fittings.
 3. Joints meeting the requirements of ANSI 21.11/AWWA C111.
 4. All mechanical joint ductile iron fittings shall be equipped with mechanical joint restraint devices as specified in Section 3.09.

3.03 HIGH DENSITY POLYETHYLENE PIPE (HDPE) FOR HORIZONTAL DIRECTIONAL DRILLING

- A. HDPE pipe shall only be used for directional bores as approved by the City Engineer.
- B. Pipe shall have a DR number 9 with a working pressure of 200 psi and be sized to provide inside diameter equal to or greater than the size shown on the plans.
- C. Materials: Polyethylene pipe and fittings shall be made from resin meeting the requirements of the Plastic Pipe Institute as PE 3408. The resin shall meet the requirements of ASTM D3350-02 with a cell classification of 345464C. The requirements of this cell classification are:

HDPE Resin Specifications

Property	Specification	Unit	Typical Value
Material Designation	PPI/ASTM		PE 3408
Material Approval	NSF #14		
Material Classification	ASTM D1248		III C5 P34
Cell Classification	ASTM D3350-02		345464C
Density	ASTM D1505	g/cm ³	0.955
Melt Index	ASTM 1238	gm/10 min	0.11
Flexural Modulus	ASTM D790	psi	135,000
Tensile Strength	ASTM D638	psi	3,200
Slow Crack Growth			
ESCR	ASTM D1693	hours in 100% igepal	>5,000
PENT	ASTM F1473	hours	>100
HDB @73 deg F	ASTM D1693	psi	1,600
UV Stabilizer	ASTM D1603	%C	2.5%

- D. Butt Fusion Fittings: HDPE fittings shall be PE 3408, HDPE, Cell Classification of 346464C as determined by ASTM D3350-02, and approved for potable water use by the AWWA. Butt fusion fittings shall have a manufacturing standard of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans. Fabricated fittings are to be manufactured using data loggers. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the Quality Control records. All fittings shall be suitable for use as pressure conduit, and per AWWA C906, have a nominal burst value of 3.5 times the working pressure rating of the fitting.
- E. Pipe Manufacturer's Quality Control: The pipe manufacturer shall have an ongoing Quality Control program for incoming and outgoing materials. HDPE resins for manufacturing of pipe shall be checked for density, melt flow rate, and contamination. The manufacturer of the HDPE resin shall certify the Cell Classification as indicated in Paragraph C above. These incoming resins shall be approved by plant Quality Control and verified as approved by NSF before being converted to pipe. Pipe shall be checked for outside diameter, wall thickness, length, roundness and surface finish on the inside, outside and end cut.
- F. HDPE pipe shall be joined together at the transition points to other mechanical joint adapters. Mechanical joint adapters shall have a manufacturing standard of ASTM D3261. They shall have a pressure rating equal to the pipe.
- G. A minimum of 100 feet of restrained joint ductile iron pipe shall be provided on the pipe preceding and the pipe following the HDPE. Appropriate restraint methods include using restrained joints equivalent to American Flex Ring or U.S. Pipe T.R. Flex.

3.04 SERVICE PIPE

- A. Polyethylene and PVC Pipe:
Polyethylene or PVC is acceptable for use between the meter and the building in accordance with the Standard Plumbing Code. Polyethylene or PVC plastic pipe is not approved for service lines from the main to the meter.
- B. Copper Pipe:
1. Seamless copper tubing meeting the requirements of ASTM B88, Type K for ¾" through 2". Copper tubing 1" and smaller shall be soft. Copper tubing larger than 1" may be hard or soft. All underground copper to copper connection is to be by compression coupling, no solder sweat joints.
 2. Contain not less than 99.90% copper and not more than 0.04% phosphorous.
 3. Suitable for use with a working water pressure of 160 psi.
 4. ¾" nominal diameter unless otherwise specified or shown on the Plans.
 5. Service pipe shall be used to connect the corporation stop with the meter yoke. Use the minimum length required to make a straight-line connection including a goose neck. The minimum length of service shall be 5 feet in order to facilitate the location of the services with metallic pipe locators.
 6. No 3" copper service pipe shall be allowed. No 3" piping on Clarksville's side of the water meter shall be allowed.
 7. All copper service piping shall be buried at a minimum depth of 24" below finished grade unless otherwise approved.
- C. Ductile Iron Pipe:
For service lines 4-inches and larger, ductile iron pipe meeting the requirements set forth in Paragraph 3.02 shall be used.

3.05 WATER SERVICE ASSEMBLIES

- A. Water Meters (all water meters are issued by the City of Clarksville):
1. AWWA C700.
 2. 5/8" x ¾" unless otherwise specified or shown on the Plans. For customers requesting water meters larger than 5/8" x ¾" the "CGW Water Customer Data Sheet" included in Appendix E shall be completed and submitted with Construction Plans for review by the City.
 3. Frost proof with a cast bronze casing and a hinged cover.
 4. Direct reading register, in gallons, unless otherwise specified.
 5. Disc or piston operated with magnetic drive.
 6. A suitable non-corrosive strainer located over the inlet to the measuring chamber.
 7. The name of the manufacturer imprinted in the lid of the register box and the meter serial number imprinted thereon.
 8. Meters shall be located in non-traffic areas.
 9. Water services shall be located near the center of the lot in non-traffic areas so that they are not in driveways. Water meters shall be located in a landscaped area near the property line unless otherwise approved by the City Engineer.

- B. Water Main Connections:
1. For all multiple unit buildings, individual taps on the main for single units (i.e. duplexes, triplexes, apartment buildings, etc.) will not be allowed. The City will own and maintain only one meter per structure.
 2. Tap water mains in the upper half of the pipe at a 45-degree angle.
 3. Do not exceed the pipe manufacturer's recommended maximum tap size.
 4. Use service saddles on all taps for PVC pipe. Water service tapping saddles for services 2" or less shall be of total brass or bronze construction with no ferrous materials. Saddles are to have double straps or extra wide single straps and shall employ a dual o-ring seal. Saddles shall be Power Seal Model 3401 or pre-approved equal.
 5. Service taps on line under construction that has not been tested and inspected by the City may be made by a qualified Contractor. Taps on existing City mains must be made by authorized City personnel unless specifically authorized by the City Engineer's office.
 6. For all 2" taps on ductile iron lines, a ductile iron epoxy coated body saddle with double stainless steel straps equivalent to Smith Blair 317 shall be furnished. For ¾" to 1" connections, ductile iron mains shall be drilled and tapped with no need for a saddle.
- C. Corporation Stops/Service Valves: Corporation stops are required for all ¾" and 1" services. Services of 2" diameter shall use a 2" ball valve with a square operating nut. All corporation stops shall have a minimum rating of 200 psi. All service valves shall have a standard valve box installed and brought to grade. Corporation stops shall meet the following criteria:
1. AWWA C800
 2. Cast of certified waterworks red brass, composed of 85% copper and 5% each of tin, lead, and zinc.
 3. Water tight and individually tested for leaks.
 4. Waterway diameter approximately equal to the nominal size of the stop.
 5. Coat or cap all threads for protection prior to installation.
 6. Manufactured by Mueller Company (Model B-25008) or pre-approved equal.
- D. Meter Yokes (all meter yokes are issued by the City of Clarksville):
1. Copper tubing with an integral brace and meter stop.
 2. Minimum rise of 7".
 3. Provide with outlets designed for the use of polyethylene or copper service pipe.
 4. Manufactured by Mueller Co. or pre-approved equal.
- E. Curb Valves: All water services less than 2" diameter must terminate with a curb ball valve immediately prior to the meter yoke location. Approved model is Mueller B25140R3 or pre-approved equal. Curb ball valves that are buried prior to the installation of a yoke shall have a bolt or pin placed in the stop wing to prevent the ball valve from being accidentally opened during back fill.
- F. Meter Boxes (all meter boxes are issued by the City of Clarksville):
1. Water meters shall be located in a landscaped area near the property line unless otherwise approved by the City Engineer.
 2. The depth of the meter yoke inlet for 5/8" – 1" meters shall be 18" to 24".
 3. The depth of the meter yoke inlet for 1 ½" – 6" meters shall be 24" to 36".

4. Meter box to be of sufficient size to facilitate easy installation and removal of the water meter.
 5. Where the service assemblies include a pressure reducing valve, sufficiently size box for installation of the pressure reducing valve in the meter box.
- G. Pressure Reducing Valves for Service Assemblies: Pressure reducing valves are the responsibility of the customer and may be installed at any point downstream of the meter in accordance with the Standard Plumbing Code and the City's "Cross Connection Control Policy and Program". Pressure reducing valves are required where the static pressure is greater than 80 psi.
- H. Service Materials: No galvanized pipe, galvanized nipples, black iron, glued plastic or sweated fittings are to be used between the main and the meter yoke. Threaded brass, slip joints, mechanical joints, and bronze/brass compression fittings are allowed.

3.06 VALVES AND VALVE BOXES

- A. Gate Valves
1. AWWA C509 or C515.
 2. Iron body, resilient seat, non-rising stem type.
 3. Stuffing boxes: O-ring seal type with two (2) rings in the stem located above the thrust collar.
 4. 2" square wrench nut for operation of the valve.
 5. Minimum design working water pressure of 200 psi for valves with diameters of 2" – 12" and 150 psi for valves with diameter of 14" – 54", unless otherwise specified or shown on the plans.
 6. Joints: ANSI A21.11 (AWWA C111).
 7. Bonnet or body markings: Manufacturer's name, year of casting, size, pressure rating, and open direction labeled with an arrow.
 8. Epoxy coat interior and exterior in accordance with AWWA C550.
 9. All main line valves and hydrants in old Clarksville, St. Bethlehem and Sango water systems including new construction are to open by turning to the right. Valve operating nuts and fire hydrants that open to the right shall be painted yellow. All main line valves and hydrants in the old New Providence, Edgoten, Kirkwood and North Montgomery areas including new construction are to open by turning to the left. Valve operating nuts and hydrants that open to the left shall be painted red. For other details contact the City Engineer's office for clarification. A copy of the valve and fire hydrant map for the City is included in [Appendix A](#) of these specifications.
 10. Shall be Mueller A-2360, M&H 7571, American Flow Control 2500 or pre-approved equal.
- B. Butterfly Valves:
1. AWWA C504.
 2. Cast iron body, rubber seated tight-closing type.
 3. Cast markings: valve size, manufacturer's name, class, direction of opening, and the year of casting.
 4. Class 250, suitable for working water pressure of 250 psi unless otherwise specified or shown on the plans.

5. Epoxy coat interior and exterior in accordance with AWWA C550.
6. All main line valves and hydrants in the old Clarksville, St. Bethlehem and Sango water systems including new construction are to open by turning to the right. Valve operating nuts and fire hydrants that open to the right shall be painted yellow. All main line valves and hydrants in the old New Providence, Edgoten, Kirkwood and North Montgomery areas including new construction are to open by turning to the left. Valve operating nuts and hydrants that open to the left shall be painted red. For other details contact the City Engineer's office for clarification. A copy of the valve and fire hydrant map for the City is included in [Appendix A](#) of these specifications.
7. Shall be Mueller LineSeal XP, M&H Style 4500, or pre-approved equal.

C. Valve Boxes:

1. Cast iron, 2-piece or 3-piece, screw type with shaft diameter of not less than 5" (John Bouchard 562-S or equal).
2. Comply with AWWA M44.
3. Heavy roadway type equipped with a cover containing the word "WATER" in raised letters on the top.
4. Base of such size as to permit its installation without allowing it to come in contact with either the valve or the pipe.
5. In paved areas, the top of the box casting shall be made level with the adjacent pavement. In unpaved areas, the box shall be level with the adjacent ground and encircled with a concrete collar 4" thick and 2' in diameter. Pre-cast concrete valve collars may also be used around valve boxes.

D. Tapping Valves and Sleeves:

1. Tapping valves shall meet all the requirements of Paragraph A above and shall be Mueller T2360-16, M&H 4751-01 or pre-approved equal.
2. Tapping sleeves shall be Mueller H-304, Ford FTSS, JCM 452, Smith Blair 665, Dresser Style 630 or pre-approved equal.
3. Tapping sleeves shall be two-piece fabricated stainless steel with adjusting/tightening bolts on each side. The fabricated sleeve must contain all stainless materials and be rated for the anticipated working pressure. Sleeves must have a stainless steel outlet flange. Sleeves with ductile iron or carbon steel flanges will not be accepted. Care must be used to assure that all bolts are equally tightened. The tapping valve is to be solidly supported with brick or block and carefully bedded to prevent shifting due to settling back fill.
4. After valve is bolted to sleeve, and with valve closed, remove test plug from the tap on sleeve and air test sleeve to 100 psi prior to making tap.
5. For taps made on 16-inch lines and larger, a ductile iron tapping sleeve, Mueller H-615 shall be required.

3.07 AIR RELEASE ASSEMBLIES FOR WATER MAINS

- A. Furnish 1" nominal diameter for 8" mains and smaller and 2" nominal diameter for 10" mains and larger, unless otherwise specified or shown on the Plans.
- B. Air release assemblies and combination air release assemblies shall consist of:

1. Double strap, bronze service clamp with neoprene gasket for PVC lines (see Paragraph 3.05).
 2. Double stainless steel strap, epoxy coated ductile iron body saddle shall be used in 2-inch assemblies for ductile iron (see Paragraph 3.05)
 3. Brass pipe of the nominal diameter required by the size of the valve. No galvanized pipe is allowed.
 4. Red brass corporation stop.
 5. Brass elbow. No galvanized materials are allowed.
 6. Bronze gate valve with hand-wheel or a metallic-body ball valve with 2-inch square nut.
 7. Air release valve.
- C. Air and Vacuum Release Valves (Combination Valves):
1. All potable water lines shall have air and vacuum release valves installed as they are indicated on the plans.
 2. The body/base of these valves shall be made from stainless steel or cast iron, and all operating parts are to be made of engineered corrosion resistant plastic materials or stainless steel.
 3. The valve shall be designed to allow larger than normal automatic orifice to provide efficient air release and minimize potential debris build up and clogging.
 4. The working pressure shall be 250 psi and shall have a 2-inch threaded connection.
 5. All air and vacuum release valves shall be model ARI D-040, Crispin Valve Model C, APCO Model 1800, or pre-approved equal.
- D. Automatic Air Release Valves:
1. All potable water lines shall have automatic air release valves as shown on the plans.
 2. Valve shall be made from stainless steel or cast iron and all operating parts are to be made of engineered corrosion resistant plastic materials or stainless steel.
 3. The valve shall be designed to allow larger than normal automatic orifice to provide efficient air release and minimize potential debris build up and clogging.
 4. The working pressure shall be 250 psi and tested to 360 psi.
 5. All air release valves shall be model ARI S-050-C, Crispin Valve Model PL, APCO Model 200, or pre-approved equal.
- E. Install air release assemblies and combination air release valves in a pre-cast concrete manhole, 48" in diameter and 48" deep, nominal diameter cast iron frame and cover. Cover to be marked "WATER".
- F. Place crushed stone from 12" below the bottom of the main to the top of the main inside the pre-cast manhole.

3.08 FIRE HYDRANTS AND BLOW-OFF HYDRANTS

- A. Fire Hydrants:
1. AWWA C502. Mueller Super Centurion 250 (Model A-423) or M & H Model #129 are the standard for Clarksville.
 2. Cast iron bodies, fully bronze mounted, designed for operation at a working water pressure of 150 psi.

3. Furnish with two 2-½" thread brass hose nozzles and one threaded 4-½" brass pumper nozzle.
4. Compression type main valve 5-¼" diameter faced with a suitable yielding material such as rubber, leather, or balata.
5. So designed that, when it is installed, no excavation is required to remove the main valve or the movable parts of the drain valve.
6. Inside diameter of barrel: at least 120 percent of the hydrant valve size.
7. Inlet connection: minimum of 6" mechanical joint on all lines, unless otherwise specified or shown on the Plans.
8. Equipped with safety flange located not more than 10" above ground and a two-piece shaft break-away assembly.
9. All main line valves and hydrants in the old Clarksville, St. Bethlehem and Sango water systems including new construction are to open by turning to the right. Valve operating nuts and fire hydrants that open to the right shall be painted yellow. All main line valves and hydrants in the old New Providence, Edgoten, Kirkwood and North Montgomery areas including new construction are to open by turning to the left. Valve operating nuts and hydrants that open to the left shall be painted red. For other details contact the City Engineer's office for clarification. A copy of the fire hydrant map is attached to this document (see Appendix A).
10. Shop paint and mark in accordance with AWWA C502. Open right hydrants yellow. Open left hydrants red.
11. Cast markings: manufacturer's name, size of the main valve, year of manufacture, and direction of opening.
12. Field touch-up, if the surface has been marred, with paint supplied by the manufacturer of the same color and type as that used during shop painting.
13. 4' bury hydrants are the standard. Where the line depth justifies additional depth, hydrant extensions shall be installed.
14. All hydrants shall be installed utilizing hydrant (swivel) tees. Unless otherwise shown on the plans, tees with all mechanical joint ends shall be used if field conditions require hydrant isolation valve to be placed away from the water main.
15. All hydrants shall be installed with a 6-inch isolation gate valve in valve box.
16. Fire hydrants shall not be installed on water lines less than 6-inch in diameter.
17. A fire hydrant shall not be located closer than five (5) feet from any driveway.
18. Per the Clarksville-Montgomery County Regional Planning Commission Subdivision Regulations, all fire hydrants shall be located on a minimum 6" water line. Fire hydrants located within a single-family residential district shall be spaced no more than 800' apart, as measured along the street right-of-way. Fire hydrants located within a multi-family, commercial or industrial district shall be spaced no more than 300' apart. A fire hydrant must be installed within 300' of the dead-end of a cul-de-sac. All fire hydrant locations shall be approved by the Clarksville Fire Department or the Montgomery County Emergency Management Agency.

B. Blow-Off Hydrants:

1. Post type having cast iron bodies, fully bronze mounted and designed for operation at a working water pressure of 150 psi.
2. Furnish with either two 1-1/2" or 2-1/2" threaded brass hose nozzles.
3. Compression type main valve 2-1/8" minimum diameter faced with a suitable yielding material such as rubber, leather or balata.

4. So designed that, when it is installed, no excavation is required to remove the main valve or the movable part of the drain valve.
5. Inside diameter of the barrel: at least 3”.
6. Inlet connection: 2” mechanical joint, unless otherwise specified or shown on the plans.
7. Equipped with a safety flange located not more than 2” above the ground.
8. Open on counter-clockwise operation, unless otherwise specified.
9. Cast markings: manufacturer’s name, size of the main valve, year of manufacture, and direction of opening.
10. Field touch-up, if the surface has been marred, with paint supplied by the manufacturer of the same color type as that used during shop painting.
11. Type of post hydrant: Mueller A-411 or M & H (Style 33 or 233).

3.09 MECHANICAL JOINT RESTRAINT DEVICE

- A. Pipe restraint: It is the intention of these specifications that all mechanical joint fittings and valves be restrained at each opening with approved mechanical joint restraint devices. Restrained fittings **do not** eliminate or replace the requirement for sufficient concrete thrust blocking and/or restrained pipe joints.
- B. PVC Restraint Devices:
 1. Restraint devices shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C111/A21.11.
 2. Devices shall have a working pressure rating equal to that of the pipe on which it is used. Ratings are for water pressure and must include a minimum safety factor of 2:1.
 3. Restraint devices shall have torque bolts.
 4. Megalug series 2000 PV produced by EBAA Iron or equal.
- C. Ductile Iron Pipe Restraint Devices:
 1. Restraint devices shall consist of multiple gripping wedges incorporated into a follower gland meeting the requirements of ANSI/AWWA C110/A21.10.
 2. Devices shall have a working pressure rating of 350 psi for 3” to 16” and 250 psi for 18” and larger. Ratings are for water pressure and must include a minimum safety factor of 2:1.
 3. Restraint devices shall have torque bolts.
 4. Megalug Series 1100 produced by EBAA Iron or equal.
- D. Restraint Devices - General:
 1. Gland body, wedges and wedge activating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536.
 2. Installation shall be performed using conventional tools and installation procedures as specified in AWWA C600 while retaining full mechanical joint deflection during assembly as well as allowing joint deflection after assembly.
 3. Proper activation of the gripping wedges shall be ensured with torque-limiting twist-off nuts.

3.10 CROSS CONNECTION

- A. All commercial properties must have backflow protection installed on incoming water lines (domestic, fire and irrigation). The type and location of commercial property backflow prevention devices shall be as follows:
1. Reduced Pressure Assemblies for domestic and irrigation.
 2. Double Check Assemblies (with fire meter) or Double Check Detector Assemblies (where approved by the City Engineer without fire meter) for all fire systems unless the system contains chemicals or is connected to an alternate water source.
 3. Backflow prevention devices shall be installed downstream of the meter before the first branch off the main line serving the building(s). Outdoor installations require protective enclosures. Inside installations require adequate drains.
- B. Residential properties are required to install backflow protection on irrigation and fire systems. Multi-story, Multi-Family (3-story or more) buildings are required to have backflow prevention on domestic, irrigation and fire system lines. Backflow prevention devices may also be required for other properties as directed by City due to connections to alternate water sources such as wells or connection with equipment that could alter water quality. The type and location of residential property backflow prevention devices shall be as follows:
1. Reduced Pressure Assemblies for all irrigation services and any domestic lines deemed necessary by the Gas and Water Department.
 2. Double Check Assemblies for all residential fire systems.
 3. Backflow prevention devices shall be installed downstream of the meter before the first branch off the main line serving the building(s). Outdoor installations require protective enclosures. Inside installations require adequate drains.
- C. **Except for fire systems**, all backflow prevention installations are required to have a strainer installed immediately upstream of the device.
- D. See Cross Connection Ordinance and Policy for more detail on installation and maintenance requirements for backflow prevention devices.

PART 4 – EXECUTION

4.01 PREPARATION

- A. Follow all material storage and handling requirements in accordance with Section 02713, Part 2.
- B. Prior to laying pipe, prepare a suitable bedding according to Section 02221.
- C. Before placing pipe in the trench, remove temporary pipe plug, field inspect for cracks or other defect; remove defective pipe from the construction site.
- D. Swab the interior of the pipe to remove all undesirable material.
- E. Prepare the bell end and remove undesirable material from the gasket and gasket recess.
- F. Locate water lines in relation to other piped utilities.

4.02 INSTALLING WATER LINES

- A. Install PVC pipe in accordance with AWWA C605.
- B. Install DIP pipe in accordance with AWWA C600.
- C. Lay all pipe on a uniform grade and with deflections not exceeding the pipe manufacturer's recommendations.
- D. After applying gasket lubricant, take extreme care to keep the spigot end from contacting the ground.
- E.hone the pipe with suitable tools or equipment to provide a smooth beveled edge on plain end sections or field cut sections.
- F. Closely follow the manufacturer's instruction in laying and joining pipe.
- G. Cut pipe for inserting valves, fittings, etc., in a neat and workmanlike manner without damaging the pipe so as to leave a smooth end at right angles to the axis of the pipe.
- H. Cover pipe with a watertight mechanical joint cap or plug during each installation of pipe segment and at conclusion of each day's construction activities.
- I. The location of all nonmetallic water mains installed under these specifications shall be marked by the use of a continuous blue tape, minimum three inches in width, made of minimum 5 mil thick polyethylene plastic with a 0.5 mil thick aluminum metallic core or backing. The tape shall be buried in the trench, above the pipe, no more than two feet below the surface. The tape shall be marked indelibly with the words "Water Main Below" or similar wording to warn unwary excavators.

- J. An insulated minimum 14-gauge solid wire tracer wire shall also be installed in the ditch immediately along the water line, either attached to or periodically wrapped around the line. The wire shall be branched off at intervals of 500' ± to connect to hydrants, valve boxes, or services to allow convenient surface access to the wire for pipe locator connection. Tracer wire shall be installed on all water mains including ductile iron water main.
- K. The Contractor shall stamp the concrete curb with a "W" where water services are located. The end of each service stub shall be marked with a 6-foot long 4x4 wooden post or metal fence post embedded 2 feet in the ground and be marked with blue paint.
- L. Installing HDPE Water Lines (only for directional drilling applications):
 - 1. HDPE pipe shall be assembled utilizing field-site butt fusion joints.
 - 2. Personnel performing butt fusion joining shall be certified by pipe manufacturer.
 - 3. Each piece of pipe must be held by a clamping device so it will not move.
 - 4. Pipe ends shall be faced to establish clean mating surfaces.
 - 5. Pipe profiles must be rounded and aligned with each other to prevent mismatch of pipe walls.
 - 6. Heat the ends of the pipe to the pipe manufacturer's recommended temperature, interface pressure, and time duration.
 - 7. Keep heater faces clean to prevent molten plastic from sticking to the heater faces.
 - 8. After heating, remove heater tool and bring molten pipe ends together with sufficient pressure to form a homogenous joint.
 - 9. Hold the molten joint immobile under pressure until cooling has occurred and joint achieves strength.
 - 10. Test line per the requirements of this Section.

4.03 SEPARATION OF WATER AND SEWER LINES

- A. Maintain a 10-foot horizontal separation, measured edge to edge, between any new or proposed water main and any existing or proposed sanitary sewer.
- B. Where conditions cause the required horizontal separation to be impractical, the water main may be laid closer provided it is laid in a separate trench and the elevation of the top of the sewer is at least 18 inches below the bottom of the water main.
- C. Where a sewer crosses under a water main, the top of the sewer shall be at least 18 inches below the bottom of the main.
- D. Where conditions cause the required vertical separation to be impractical, the water main shall be relocated to provide the required separation or else reconstructed with mechanical joint ductile iron pipe for a distance of 10 feet on each side of the sewer with a full joint of the water main centered over the sewer.
- E. Where sewers must be constructed over water mains or less than 18 inches below the water main, the sewer shall be designed and constructed equal to water main standards and pressure tested to assume water tightness.

- F. Additional protection such as concrete encasement shall be installed where directed by the Engineer.
- G. To prevent cross connection, comply with the City's "Cross Connection Control Policy and Program."

4.04 INSTALLING APPURTENANCES

- A. Set all valves, fittings, hydrants, and other special fittings in a neat workmanlike manner. Tapping valves are to be supported with blocking and surrounding bedding carefully compacted to prevent settlement.
- B. Use thrust blocks, pipe anchors, or other approved means to prevent displacement of other fittings as shown on the Project Documents. Do not allow concrete to cover nuts and bolts on fittings. Gate valves on fire hydrant leads are to be restrained or blocked independently of the hydrant blocking so that the hydrant may be excavated and removed with the valve closed. Mechanical restraint is to be by the use of MegaLug devices or other similar devices. Underground use of galvanized all thread rod is not allowed except where specifically approved by the Engineer. Fittings for taps made on the reverse side of the main must be restrained joints. All mechanical joints are to be restrained with mechanical joint restraining devices as set forth in Paragraph 3.09. These restraining devices **do not** eliminate the requirement for sufficient concrete thrust blocking and/or restrained joint pipe.
- C. Erect hydrants to stand plumb with the pumper nozzle facing the road. Nozzles shall be installed a minimum of 12 inches above finished grade.
- D. Enhance drainage of hydrants by using 6 cubic feet of gravel around base of hydrant. Do not allow concrete thrust block to obstruct drain holes.
- E. Close dead end pipe with a mechanical joint solid sleeve and plug, and equip with blow-off assemblies, where shown on the drawings.

4.05 CONNECTING NEW SYSTEM TO EXISTING SYSTEM

- A. Initial filling of the new line shall be made at only one point and shall be via a metered backflow assembly (large sizes may not be metered at option of City) which is provided by the City, installed by the Contractor, and then removed by the Contractor and returned to the City after acceptance of the line. The Contractor is responsible for providing all necessary sleeves, reducers, or other fittings to install and remove the backflow assembly from the main.
- B. All connection of new main extensions to existing systems shall be valved to prevent existing customers from being included in the new system area during testing and disinfection procedures.
- C. Connections of new mains to existing mains shall normally be made by the use of a tapping valve in order to avoid disrupting service to existing customers.
- D. Any wet connections involving the shutdown of existing system valves shall be specifically approved by and coordinated with the City Engineer's Office. Such coordination shall include

the responsibility of the Contractor in notifying affected customers and scheduling shutdowns to minimize customer inconvenience. An authorized shutdown shall not relieve the Contractor from liabilities resulting from shutdowns such as damaged water heaters, discolored water, etc. The turning of valves shall be scheduled with the City's representative.

- E. Manipulation of valves for filling or flushing lines shall be minimized to avoid accumulations of air and discolored water in the affected areas. No water valves shall be operated by anyone other than City of Clarksville personnel.
- F. Once new systems are fully activated, following disinfection, flushing and testing, the Contractor shall inspect each valve that has been installed or manipulated to ensure that all valves are in fully open position.
- G. The Contractor will be charged for the consumption volume of water by flushing, filling, leaks, etc. that exceeds twice the volume of the installed pipe.

4.06 HIGHWAY AND RAILROAD CROSSINGS

- A. Perform highway crossings by the open cut method, unless otherwise shown on the Drawings or required by the appropriate authorities.
- B. Boring and jacking, tunneling, or horizontal directional drilling of crossings, if necessary, will be performed in accordance with the appropriate specification sections.

4.07 WATER LINE PRESSURE TESTS

- A. All newly laid pipe or any valved section thereof shall be subjected to hydrostatic pressure testing. Conduct hydrostatic testing in accordance with AWWA C600 for ductile iron pipe or AWWA C605 for PVC pipe.
- B. Where practicable, pipelines shall be tested in lengths between line valves or plugs of no more than 3,000 feet.
- C. Hydrostatic testing shall be conducted only with potable water. Due to the inherent safety hazard potential associated with testing components and systems with compressed air or other compressed gases, pressure testing shall never be accomplished using compressed air.
- D. The Contractor shall furnish all gauges, recording devices, meters, pumps, pipe, connections and other equipment required to conduct the test and shall maintain said equipment in condition for accurate testing as determined by the Owner. Gauges used for pressure tests shall be oil-filled gauges.
- E. Hydrostatic test results shall be recorded on an appropriate chart recorder. The Contractor shall furnish a recording gauge and water meter for recording pressure charts and for measuring makeup water used during the hydrostatic testing. Recording pressure charts shall be submitted to the Owner at the conclusion of testing. The pressure recording device shall be suitable for outside service, with a range from 0–300 psig, 24-hour spring wound clock, designed for 9-inch charts, and shall be approved by the Engineer. For Contractor's information only, such pressure recording devices may be available from Foxboro Company,

Foxboro, Massachusetts; Bristol Division of ACCO, Waterbury, Connecticut; or Weksler Instruments Corporation, Freeport, New York.

- F. Prior to testing, the Contractor shall place sufficient backfill to prevent pipe movement. When local conditions require that the trenches be backfilled immediately after the pipe has been laid, the testing may be carried out after backfilling has been completed but before placement of permanent surfacing. The Contractor shall ensure that thrust blocking or other types of restraining systems will provide adequate restraint prior to pressurizing the pipeline.
- G. Cross Connection Control: When existing water mains are used to supply test water, they should be protected from backflow contamination by temporarily installing a double check valve assembly between the test and supply main or by other means approved by the Engineer. Prior to pressure and leakage testing, the temporary backflow protection should be removed and the main under test isolated from the supply main.
- H. Test Pressure Requirements:
 - 1. The test pressure shall not be less than 1.25 times the stated working pressure of the pipeline measured at the highest elevation along the test section and not less than 1.5 times the stated working pressure at the lowest elevation of the test section, but not greater than 200 psi.
 - 2. The test pressure shall not exceed the thrust restraint design pressure or 1.5 times the pressure rating of the pipe or joint, whichever is less (as specified by the manufacturer).
 - 3. The test pressure shall not exceed the rated working pressure of the valves when the pressure boundary of the test section includes closed, resilient seated gate valves or butterfly valves.
 - 4. Valves shall not be operated in either direction at a differential pressure exceeding the rated valve working pressure. A test pressure greater than the rated valve working pressure can result in trapped test pressure between the gates of a double-disc gate valve. For tests exceeding the rated valve working pressure, the test setup should include a provision, independent of the valve, to reduce the line pressure to the rated valve working pressure on completion of the test. The valve can then be opened enough to equalize the trapped pressure with the line pressure, or the valve can be fully opened if desired.
- I. Test Procedure:
 - 1. Each valved section of pipeline shall be slowly filled with potable water using a metered backflow-protected assembly provided by the Owner. When venting air from pipelines, it is important to limit the pipeline fill rate to avoid excessive surge pressures when the water reaches the air venting opening(s).
 - 2. Before applying the specified test pressure, air shall be expelled completely from the pipeline section under test. If permanent air vents are not located at all high points, corporation cocks shall be installed at such points to expel air as the line is filled with water. After all the air has been expelled, close the corporation cocks and apply the test pressure. At the conclusion of the pressure test, remove the corporation cocks and plug or leave in place at the discretion of the Engineer.
 - 3. The specified test pressure shall be applied using a suitable pump connected to the pipeline in a manner satisfactory to the Engineer. The specified test pressure shall be based on the elevation of the lowest point of the pipeline or section under test and

corrected to the elevation of the test gauge, in accordance with test pressure requirements specified herein.

4. The pipeline shall be allowed to stabilize at the test pressure before conducting the hydrostatic test. This may require several cycles of pressurizing and bleeding trapped air prior to beginning the test. It is recommended that the line remain pressurized for a minimum of 24 hours before testing in order for joints to tighten and pockets of air to dissolve in the water.
5. The hydrostatic test shall be at least 2 hours in duration after reaching the specified test pressure where joints are exposed and at least 8 hours where joints are covered.
6. The test pressure shall not vary by more than +/- 5 psi for the duration of the test. Test pressure shall be maintained within this tolerance by adding makeup water through the pressure test pump into the pipeline. The amount of makeup water added shall be accurately measured (in gallons per hour) by suitable methods and shall not exceed the applicable testing allowance as specified herein.

J. Visual Inspection:

Any exposed pipe, fittings, valves, hydrants and joints shall be examined carefully during the hydrostatic pressure test. Any damaged or defective materials that are discovered during or following the pressure test shall be repaired or replaced at the Contractor's expense, and the test shall be repeated until satisfactory results are obtained. Water main repair and replacement shall be in accordance with Part L of this Paragraph.

K. Testing Allowance:

1. Testing allowance shall be defined as the maximum quantity of makeup water that is added into a pipeline undergoing hydrostatic pressure testing, or any valved section thereof, in order to maintain pressure within +/- 5 psi of the specified test pressure (after the pipeline has been filled with water and the air has been expelled).
2. No pipe installation will be accepted if the quantity of makeup water is greater than that determined by the following formula:

$$L = \frac{S * D * (P)^{\frac{1}{2}}}{148,000}$$

Where:

L = testing allowance (makeup water), in gallons per hour

S = length of pipe tested, in feet

D = nominal diameter of the pipe, in inches

P = average test pressure during the hydrostatic test, in pounds per square inch (gauge pressure)

3. This formula is based on a testing allowance of 10.5 gpd/mile/inch of nominal diameter at a pressure of 150 psi. Values of testing allowance at various pressures are shown in the following table. When testing against closed metal-seated valves, an additional testing allowance per closed valve of 0.0078 gal/hr/inch of nominal valve size shall be allowed. When hydrants are in the test section, the test shall be made against the main valve of the hydrant.

Hydrostatic Testing Allowance per 1,000 feet of pipeline (gallons per hour)*											
Average Test Pressure (psi)	Nominal Pipe Diameter (inches)										
	4	6	8	10	12	14	16	18	20	24	30
250	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92	2.14	2.56	3.21
225	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82	2.03	2.43	3.04
200	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29	2.87
175	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15	2.68
150	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99	2.48
125	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81	2.27
100	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62	2.03
75	0.23	0.35	0.47	0.59	0.70	0.82	0.94	1.05	1.17	1.40	1.76
50	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.96	1.15	1.43

* If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

- L. Acceptance of the installation shall be determined on the basis of testing allowance only. Should any test of pipe laid disclose leakage greater than that specified, the Contractor shall, at his own expense, locate and repair the defective joints until the leakage is within the specified allowance. All visible leaks are to be repaired regardless of the allowance used for testing. Hydrostatic test results shall be recorded on an appropriate chart recorder as specified herein. A copy of the test chart shall be provided to the Engineer.

- M. To repair or replace damaged or defective water main pipe, the Contractor shall maintain positive pressure on the main (valves left partially open) while he excavates around and under (2' clearance) the pipe so that water can be pumped out of the excavation pit before it enters the newly constructed main during the repair process. Contractor shall have adequate pumping capacity to prevent any trench water or debris from entering the main during this process. The interior of all pipe and fittings shall be sprayed with a 1% hypochlorite solution before they are installed in the repair process. To produce this one percent hypochlorite solution, one gallon of 5% hypochlorite bleach can be diluted with four (4) gallons of water. Flooding or contamination of the main during this process shall invoke Paragraph 2.05 of Section 02713.

STANDARD OPERATION PROCEDURES FOR WATER MAIN DISINFECTION

4.08 CLEANING AND DISINFECTING OF WATER LINES

- A. Disinfection Tests: Conduct disinfection tests in accordance with AWWA C-651.
 1. During construction, take precautions to protect pipe interiors, fittings, and valves against contamination. Follow all Material Storage and Handling Requirements in Section 02713 Part 2.
 2. All chlorine products shall be NSF approved chlorine. Pool chlorine products shall not be used.
 3. The Granular Method shall be used as the standard disinfection method on all newly installed pipelines unless prior approval for the continuous feed or slug method is obtained from the Engineer or his representative.

4. Granular Method (Standard Method):
 - a) Obtain NSF approved granular chlorine product from the Clarksville Gas and Water Department Warehouse. All granular chlorine used in pipeline disinfection must be obtained from Clarksville Gas and Water. A fee may be charged to cover the cost of this product. This chlorine product shall be OxyChem ACL 60 Disinfecting Granules (sodium dichloroisocyanurate) with approximately 62% available chlorine or approved equal.
 - b) Place granular chlorine in the pipe at the beginning of the line, beginning of each branch line, and at 500-foot intervals (every 25 pipe joints).
 - c) Place enough granular chlorine in the pipe to achieve a 25 ppm dosage in the pipeline. Contractor shall obtain granular chlorine in pre-measured bottles from the Clarksville Gas and Water Department to ensure proper dosage is achieved (see Table I).
 - d) Slowly fill the pipeline with water and eliminate all air pockets. Hold the disinfection solution in the pipeline for 24 hours.
 - e) Flush thoroughly to clear the strong chlorine solution from the pipelines before bacteriological sampling (see Item 8 of this section).

TABLE I - GRANULAR METHOD	
GRANULAR CHLORINE DOSE SIZE FOR 500 FT OF PIPE AT 25 PPM (MG/L)	
Pipe Diameter (in)	Dose Size (oz)
2	0.5
4	2
6	4
8	7
10	11
12	16
16	28
24	63
30	99
36	142

5. Continuous Feed Method (Special Approval Required):
 - a) Granular chlorine may be placed (optional) in the pipeline during construction (see Granular Method).
 - b) Thoroughly flush the pipeline to remove all sediments and air pockets.
 - c) Add a continuous dose of chlorine while flowing water slowly into the new main until a 25 ppm chlorine concentration is reached throughout the new pipelines. Contractor shall use Sodium Hypochlorite to obtain the 25 ppm dosage (see Table II for total amount of Sodium Hypochlorite to be fed to establish 25 ppm dosage for 500 feet of pipe). In the alternative, granular chlorine can be mixed to obtain the 25 ppm concentration (see Table I for total amount of granular chlorine to be fed to establish 25 ppm concentration for 500 feet of pipe). Measure the chlorine residual at various locations to conform proper residual has been achieved.
 - d) Hold the disinfection solution in the lines for 24 hours and confirm that the chlorine residual is at least 10 ppm after 24 hours.
 - e) Flush thoroughly to clear the strong solution from the pipelines before bacteriological sampling (see Item A-8 of this section).

TABLE II – CONTINUOUS FEED METHOD			
SODIUM HYPOCHLORITE DOSE SIZE FOR 500 FT OF PIPE AT 25 PPM (MG/L)			
Pipe Diameter (in)	Sodium Hypochlorite Volume (gal)		
	5.0%	6.15%	10.0%
2	0.04	0.03	0.02
4	0.16	0.13	0.08
6	0.37	0.30	0.18
8	0.65	0.53	0.33
10	1.0	0.83	0.51
12	1.5	1.2	0.73
16	2.6	2.1	1.3
24	5.9	4.8	2.9
30	9.2	7.5	4.6
36	13.2	10.7	6.6

6. Slug Method (Special Approval Required):
 - a) Granular chlorine may be placed (optional) in the pipeline during construction (see Granular Method).
 - b) Thoroughly flush the line to remove all sediments and air pockets.
 - c) Admit water to the new main very slowly and dose with enough chlorine to produce a residual of at least 100 ppm. Contractor shall use Sodium Hypochlorite or granular chlorine according to Table III to obtain the 100 ppm concentration. The objective is to produce a column of 100 ppm chlorine solution which will move slowly as a slug through the new pipeline. The column or slug of highly chlorinated water must be long enough to contact all surfaces of the pipe interior for at least 3 hours. Measure chlorine residuals in the slug as it moves down the pipeline. The residual must be maintained over 50 ppm.
 - d) For emergency line repair situations only, to be performed only by, or in the presence of, authorized City personnel, and where no service connections exist, the standard 100 ppm concentration can be substituted for a 300 ppm solution

and the contact time can be reduced from the standard 3 hours to 15 minutes. Table IV indicates the Sodium Hypochlorite and granular chlorine dose sizes to be used for this method. Refer to Paragraph 4.08B for appropriate situations and procedures.

- e) Flush thoroughly to clear the strong chlorine solution from the pipelines before bacteriological sampling.

TABLE III – SLUG METHOD				
CHLORINE DOSE SIZE FOR 500 FT OF PIPE AT 100 PPM (MG/L)				
Pipe Diameter (in)	Sodium Hypochlorite Volume (gal)			Granular Chlorine (oz. of weight)
	5.0%	6.15%	10.0%	62%
2	0.2	0.1	0.1	2.1
4	0.7	0.5	0.3	7.1
6	1.5	1.2	0.7	16
8	2.6	2.1	1.3	28
10	4.1	3.3	2.0	44
12	5.9	4.8	2.9	63
16	10	8.5	5.2	112
24	23	19	12	253
30	37	30	18	395
36	53	43	26	569

TABLE IV – SLUG METHOD				
CHLORINE DOSE SIZE FOR 500 FT OF PIPE AT 300 PPM (MG/L)				
Pipe Diameter (in)	Sodium Hypochlorite Volume (gal)			Granular Chlorine (oz. of weight)
	5.0%	6.15%	10.0%	62%
2	0.5	0.4	0.2	6.3
4	2.0	1.6	1.0	21
6	4.4	3.6	2.2	48
8	7.8	6.4	3.9	84
10	12	10	6.1	132
12	18	14	8.8	190
16	31	25	16	336
24	70	57	35	758
30	110	90	55	1185
36	159	129	79	1706

- 7. While chlorine is being applied, manipulate valves so that the treatment dosage will not flow back into the line that is supplying the water. Continue application of chlorine until the entire line being treated is filled with the chlorine solution.
- 8. Final Flushing: Conduct final flushing in accordance with AWWA C651.
 - a) After applicable retention period, flush heavily chlorinated water from the line until chlorine concentration in water leaving the main is no higher than that generally prevailing in the system, or less than 2 mg/l. Unless special approval

is obtained from City Engineer, all water shall be flushed through de-chlorinating diffusers rated to remove the appropriate chlorine concentration (Arden Industries' Bazooka with Liquid Calcium Thiosulfate Feed or pre-approved equal). The City may, at its option, provide such devices to the Contractor while the line is flushed. The Contractor must contact the Inspector prior to flushing any water from the newly constructed line. The Inspector shall provide de-chlorinating diffuser(s) to the Contractor before flushing. If no diffusers are available through the city, the Contractor shall be required to provide diffusers. The Inspector shall approve the flushing location. The Inspector shall also check the chlorine level in the main before final flushing. If the residual chlorine level is out of the effective range of the de-chlorinating diffuser, the Inspector shall require the Contractor to wait until the residual level has dropped to within the range of the de-chlorinating diffuser before flushing.

- b) In the alternative, but only with special approval from the City Engineer, neutralizing chemicals may be applied externally as the water reaches the ground. Perform such flushing only at sites where City Engineer has approved. If no approved point of discharge is available, neutralizing chemicals must be applied to the water in order to neutralize the chlorine residual. The amount of chemicals required to neutralize various residual chlorine concentrations in 100,000 gallons of water are shown in Table V.
- c) Flushing Velocity: The velocity of water used to flush the line shall be at least 2 fps. The flow rates required to produce this velocity varies depending on pipe diameter. To approximate this velocity, refer to Table VI to select the proper number of taps or 2-½" Fire Hydrant Nozzles to open at the end of the line.
- d) Minimum Flushing Time: At minimum, the line shall be flushed to remove two complete volumes of water through the newly constructed pipeline, approximately 7 minutes per 500 ft. The Disinfection, Flushing, and Pressure Testing Worksheet presents the minimum flushing time for various lengths of pipe.
- e) Additional Flushing: After flushing pipe for minimum time specified in Item d, check for trapped air at Air Release Valves, Blow-offs and services at high points. Verify that all mud, air cloudiness, or other discoloration is absent from flushing stream. If such problems exist, continue to flush line until the stream is clear.
- f) Once a line has been flushed, test to make certain that the residual chlorine in the water is within acceptable limits.
- g) It must be noted that flushing is no substitute for taking preventative measures before and during the laying of water lines. Certain contaminants – especially those in caked deposits – are difficult or even impossible to remove by flushing, no matter how high the velocity. Furthermore, in pipe with diameters of 16" or more, it can be difficult to achieve even the minimum recommended flushing velocity of 2.5 fps.

Residual Chlorine Concentration (mg/L)	Sulfur Dioxide (SO ₂) lb	Sodium Bisulfite (NaHSO ₃) lb	Sodium Sulfite (Na ₂ SO ₃) lb	Sodium Thiosulfate (Na ₂ S ₂ O ₃ ·5H ₂ O) lb
1	0.08	1.2	1.4	1.2
2	1.7	2.5	2.9	2.4
3	8.3	12.5	14.6	12.0
4	41.7	62.6	73.0	60.0

Pipe Diameter (in)	Number of 1" Taps	Number of 2" Taps	Number of 2-1/2" FH Nozzles
2	1	---	---
4	1	1	1
6	---	1	1
8	---	1	1
10	---	2	1
12	---	2	2
16	---	4	2
24	---	-	4
30	---	---	6
36	---	---	8

9. Bacteriological Testing:

- a) After a water line has undergone final flushing but before it is placed into service, collect a sample for bacteriological testing from the end of that line. In the case of extremely long lines, take additional samples if the Owner so directs. Bacteriological samples shall be collected at approximately 2,500-foot intervals with samples near the beginning point and at the end point of each section of line. Where sanitary conditions were not maintained before, during or after construction, an additional bacteriological sample shall be collected from a location representing the water from the contaminated area. Unsanitary conditions include failure to document sanitary handling of materials, to conduct construction inspections and to maintain records, and to document sanitary practices during construction and other hazards such as trench flooding during construction.
- b) Collect these samples in sterile bottles treated with sodium thiosulfate. Fire hydrants shall be used to take samples. Other locations may be utilized if no fire hydrant is available.
- c) Samples will be collected by water plant personnel to be tested for bacteriological quality in order to determine if they contain any coliform organisms. The sample is required to be taken 48 hours after flushing all new

- pipelines. If the initial disinfection fails to produce satisfactory samples, repeat disinfection until satisfactory samples are obtained.
- d) When the samples tested are found to be satisfactory, the water line may be placed in service.
 - e) The Contractor shall fill out and sign a Disinfection, Flushing, and Pressure Testing Worksheet provided by the City documenting adherence to the Standard Specifications. Contractor shall obtain a blank worksheet from the City Engineer's Office upon issuance of a construction permit. The Contractor shall complete the worksheet during the construction process and present a signed copy to the Inspector prior to bacteriological testing. If improper or inadequate documentation is presented, the Contractor shall be deemed to have failed to follow the specifications and shall be required to follow the cleaning and chlorination procedures specified in Paragraph 2.05.

Section B and C below are for Authorized City Personnel or Contractors working under direct supervision of Authorized City Personnel.

- B. Positive Pressure Method:
1. Contact Tennessee One Call to have all other utilities located; notify Service Department and Water Treatment Plant of areas affected.
 2. All attempts will be made to repair line under "wet" conditions to avoid or eliminate possible contaminants from entering the system.
 3. Close nearest isolation valves on the downstream side of the leak. Reduce the flow from the upstream side of the leak by throttling back the remaining valve, leaving **positive pressure** on the line. DO NOT OPEN ANY FIRE HYDRANTS TO REDUCE LINE PRESSURE PRIOR TO OPENING THE TRENCH TO A DEPTH OF AT LEAST 18-INCHES BELOW THE LINE. This will prevent contaminants from entering the system. Complete the repair trench excavation.
 4. After excavation of the repair trench is complete (to a depth of at least 18-inches below the line) close the remaining valve after removing the standing water to fully expose the pipe 360 degrees. Treat any standing water now remaining in the repair trench with ½ oz. of Granular Chlorine (62% purity) for every one hundred gallons of trench water to achieve a 25-ppm solution.
 5. To ensure a clean repair, inspect around the pipe in and near the damaged area and remove any debris, soil, or other material from the damaged area. Swab or spray the damaged area of the pipe and interior of all repair clamps or other appropriate devices with a 1% hypochlorite solution (5.2 fluid oz. of 6.15% bleach/quart of water) before installation. Complete the repair.
 6. Open the appropriate valve(s) and flush the water main toward the repair location from both directions if valve and hydrant locations permit. Continue flushing until all discolored water is eliminated and a satisfactory chlorine residual is reached.
 7. Before the water main is returned to full service, collect a single water sample at a point nearest the repaired section. If direction of flow can be determined, the sample should be collected from downstream of the break repair. If direction of flow cannot be determined, samples should be collected from above and below the break repair. These samples should be coded "D". This sample is to be delivered as soon as possible to the Water Treatment Plant for bacteriological testing.
 8. Check all valves to insure they have been returned to the open position.
 9. If the test results are negative, the test results will serve as a record of compliance and

no future work is required.

10. Fill out all appropriate forms indicating disinfection procedures.
 11. If the test results are positive, then additional sampling should be undertaken immediately. A total of three (3) additional samples should be taken. The first additional sample should be taken from the original sampling location and the other two additional samples should be taken above and below the original sampling location. These three samples should be coded "R". If all three samples are negative, then no further work is required. If any of the additional samples is positive, then follow the normal repeat monitoring procedure.
- C. Dewatered Method: If it is not possible to maintain positive pressure as stated above and the pipe must be dewatered prior to opening and preparing the repair trench, then the entire section of pipe must be disinfected in accordance with Section 6 of this document (Slug Method), which is derived from Section 4.7.4 of AWWA C651-99.
1. Contact Tennessee One Call to have all other utilities located; notify the Service Department and Water Treatment Plant of areas affected.
 2. Close the nearest isolation valves on all sides of main break.
 3. If there are customers in the isolated area, turn off all services at the lock wing on the meter yokes. Remove the meters. This will prevent the disinfectant from entering the customer's premises.
 4. In order to lessen the possibility of additional contaminants from entering the exposed line, after excavation of the repair trench is complete, pump the water down below the main line. Treat the standing water in the repair trench with ½ oz. of granular chlorine for every one hundred gallons of trench water to achieve a 25-ppm solution.
 5. Clean the area around the pipe. Swab or spray the interior of all repair pipe and fittings with a 1 percent hypochlorite solution (5.2 fluid oz. of 6.15% bleach/quart of water) before installation.
 6. The line should be properly disinfected by the slug method (see Appendix C) using a chlorine dosage of 100 mg/L and a contact time of at least 3 hours for areas where service connections are present.
 7. In areas where no service connections exist the line can be properly disinfected by the slug method using a chlorine dosage of 300 mg/L and a contact time of at least 15 minutes.
 8. After the disinfectant has been added to the line by using a sodium hypochlorite solution or calcium hypochlorite granules, an upstream valve should be opened slightly, along with an opened downstream hydrant, to allow air and highly discolored contaminated water to be removed. The slow flowing concentrated slug will gradually move through the pipe allowing all parts to be exposed to the disinfectant.
 9. Once the highly discolored contaminated water has been flushed, the valve and flushing hydrant should be closed to allow for the prescribed disinfectant contact time.
 10. After the prescribed contact time has been reached, prepare to treat (de-chlorinate) the highly chlorinated water to be flushed from the isolated line if there is a possibility that the discharge will cause any damage to the environment.
 11. Open the upstream valve and the downstream hydrant and flush until all discolored water is eliminated, de-chlorinating the discharge if necessary. Test for highly chlorinated water remaining in the line and continue flushing if necessary until elimination is successful and the concentration is no higher than that in the prevailing water in the surrounding area.
 12. Before the water main is returned to full service, collect a single water sample at a

point nearest the repaired section. If direction of flow can be determined, the sample should be collected from downstream of the break repair. If direction of flow cannot be determined, samples should be collected from above and below the break repair. These samples should be coded "D". This sample is to be delivered as soon as possible to the Water Treatment Plant for bacteriological testing.

13. Open the customer's services at the lock wings and flush the service lines. Reinstall meters.
14. Open the remaining valves in the isolated area.
15. Flush the area again at the highest hydrant in the area to insure the elimination of any discolored water.
16. If the test results are negative, the test results will serve as a record of compliance and no future work is required.
17. Fill out all appropriate forms indicating disinfection procedures.
18. If the test results are positive, then additional sampling should be undertaken immediately. A total of three (3) additional samples should be taken. The first additional sample should be taken from the original sampling location and the other two additional samples should be taken above and below the original sampling location. These three samples should be coded "R". If all three samples are negative, then no further work is required. If any of the additional samples is positive, then follow the normal repeat monitoring procedure.



CGW- _____

WS- _____

DISINFECTION, FLUSHING AND PRESSURE TESTING WORKSHEET
(MANDATORY BEFORE BACTERIOLOGICAL TESTING)
PRESENT TO INSPECTOR

Date: _____

Project Name: _____

Material: PVC D.I. Size: _____

Length of Section: _____

Contractor: _____

Instructions:

1. This worksheet references the Granular Method in the City of Clarksville's Standard Specifications.
2. This worksheet must be properly filled out and presented to inspector before bacteriological testing.
3. Use one worksheet per test section. If test pit is moved, use a new sheet. If pipe diameter changes, use a new sheet.

A. DISINFECTION

1. Select Granular Chlorine Dose Size

Pipe Dia (in)	Dose Size (oz)
2	0.5
4	2
6	4
8	7
10	11
12	16
16	28
24	63
30	99
36	142

2. Select Number of Doses Needed

Pipe Length (ft)	No. of Doses
500	1
1000	2
1500	3
2000	4
2500	5
3000	6
3500	7
4000	8
4500	9
5000	10

3. Calculate Total Granular Chlorine

$$\underline{\hspace{2cm}} \times \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ oz.}$$

Dose Size (Table 1) No. of Doses (Table 2)

1. Check granular chlorine container for CGW approval (62% purity, NSF stamp)
2. Place 1 dose at the beginning of the line
3. Place 1 dose every 500 feet during construction
4. After construction, install test pit (back flow/meter assembly by sleeving into the line)
5. Partially open valve at test pit
6. Adjust valve to slowly fill line
7. Open blow-offs, services, and air release valves at high points to remove air
8. Allow water to sit for at least 24 hours

B. FLUSHING

1. Select Number of Flushing Ports
(circle below)

Pipe Dia (in)	No. of 1" Taps	No. of 2" Taps	No. of FH Nozzles
2	1	-	-
4	1	1	1
6	-	1	1
8	-	1	1
10	-	2	1
12	-	2	2
16	-	4	2
24	-	-	4
30	-	-	6
36	-	-	8

2. Select Minimum Flushing Time
(circle below)

Pipe Length (ft)	Min. Flush Time (min)
500	7
1000	14
1500	20
2000	27
2500	34
3000	40
3500	47
4000	54
4500	60
5000	67

3. Select Flushing Location
(list below)

- 4. Contact Inspector and attach dechlorinating diffuser (provided by Inspector) to each flushing port and open.
- 5. Fully open valve at test pit.
- 6. Flush for time selected in Step 2.
- 7. Check for trapped air at ARV's, blow-offs and services at high points.
- 8. Check for mud, air, and cloudiness (flush until clear).

C. PRESSURE TESTING

- 1. Apply 200 psi maximum test pressure (measured at pit or lowest point) through test pit.
- 2. Fix all defective parts of water line according to Standard Specifications
- 3. Call Inspector to witness pressure test.
- 4. The pressure held at _____ psi for _____ hrs.

Inspector's Initials

D. SAMPLING PORTS

- 1. Provide smooth copper brass sampling taps and spacing described in Standard Specifications or required by City's Distribution Operator.
- _____
No. of Taps

E. SKETCH

Attach a simple sketch identifying this section of test pit location, line, sampling location, flushing locations, and chlorine dosing locations.

F. BACTERIOLOGICAL TESTING

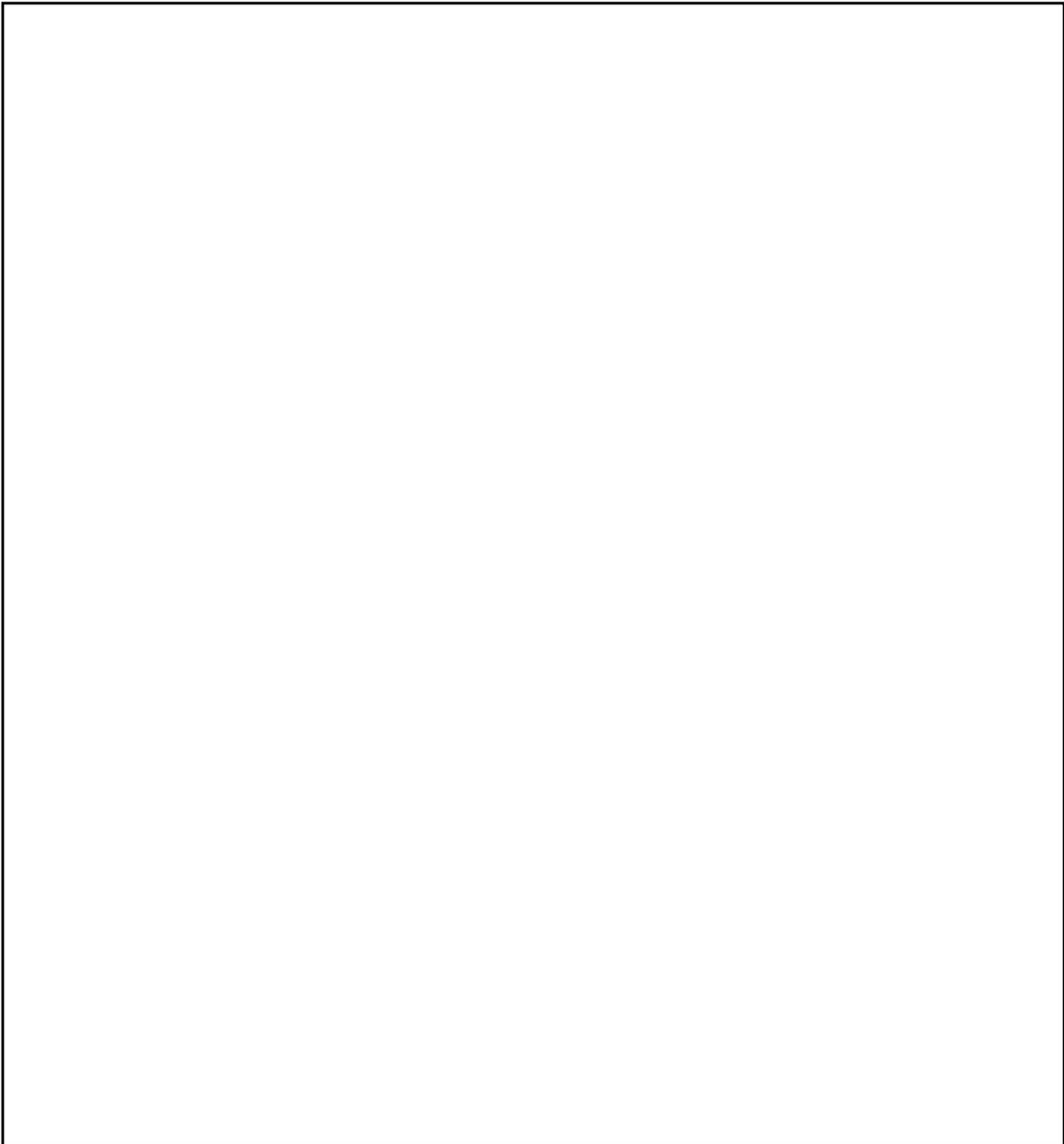
- 1. Sign statement below.
- 2. Call inspector for bacteriological testing.

G. STATEMENT

I certify that the above information is correct and this water is ready to be tested by the City's Distribution Operator for bacteriological contamination.

Contractor's Authorized Signature

DISINFECTION, FLUSHING AND PRESSURE TESTING SKETCH



INCLUDES THE FOLLOWING FEATURES:

- | | | | |
|--------------------------------------|---------------------------------------|--|--------------------------------------|
| <input type="checkbox"/> Test Pit | <input type="checkbox"/> Sample Ports | <input type="checkbox"/> Chlorine Dosing Locations | <input type="checkbox"/> North Arrow |
| <input type="checkbox"/> Flush Ports | <input type="checkbox"/> Water Line | <input type="checkbox"/> Street Names | <input type="checkbox"/> Other Info |

END OF SECTION

SECTION 02715

FIRE SERVICE WATER METERS

PART 1 - GENERAL

1.01 WORK INCLUDED

Installation of fire service meters, vaults and related appurtenances as shown on the Contract Drawings.

1.02 RELATED WORK

Section 02713: Water Distribution Systems

PART 2 - PRODUCTS

2.01 COLD WATER METERS/FIRE SERVICE COMPOUND METER TYPE

- A. General: The City of Clarksville shall issue all fire service meters in exchange for a fee payable at Gas and Water Department Service Center. All meters furnished shall be manufactured by a registered ISO 9001 quality standard facility. Acceptable meters shall have a minimum of five years of successful field use. All specifications shall meet or exceed the latest revision of AWWA C703.
- B. Type: Meters shall consist of a combination of an AWWA Class II in-line horizontal axis turbine for measuring high rates of flow and a positive displacement bypass meter conforming to AWWA C700 for measuring low rates of flow. An automatic valve shall direct the flow from the bypass meter to the mainline meter as flow rates increase and back to the bypass meter as flow rates decrease. All components of the meter assembly shall be both UL (Underwriter's Laboratory) listed and FM (Factory Mutual) approved for fire service use.
- C. Capacity: The capacity of the meters in terms of normal operating range, maximum rate for continuous use, maximum loss of head, and extended low flow capability shall be as provided in the following table:

Size (inches)	Normal Operating Range (gpm)	Maximum Rate for Continuous Use (gpm)	Maximum Loss of Head at Max Rate (psi)	Extended Low Flow (gpm)
4"	¾ - 1200	1200	9	3/8
6"	1 ½ - 2500	2500	10.5	3/4
8"	2 - 4000	4000	10.5	1
10"	2 - 6500	6500	9	1

- D. Case and Cover
1. The meter body, strainer body, and valve body shall be fabricated steel with a coating of fusion-bonded epoxy both internally and externally. The meter body shall be welded to the valve body effecting a uni-body construction with the valve. The strainer outlet and meter inlet shall be connected by a Style 77 Victaulic or other UL Listed/FM Approved grooved coupling. The meter assembly shall have a rated working pressure of 175 psi.
 2. The meter cover shall be cast of lead free brass containing a minimum of 85% copper such as EnviroBrass™ II. An arrow indicating direction of flow shall be cast in raised characters on the cover. The cover shall have a rated working pressure of 175 psi. The cover shall contain a calibration vane for the purpose of calibrating the turbine measuring element while in-line and under pressure. The calibration vane shall be mounted under the register that is attached in a tamper-resistant manner.
- E. Strainer
1. Meters shall be supplied with a strainer designed and approved for the fire service used by UL and FM, and shall have a rated working pressure of 175 psi.
 2. The Strainer shall be constructed of steel and coated with fusion-bonded epoxy. The strainer basket shall be constructed of AISI Type 18-8 stainless steel. The strainer shall contain a flushing port located near its bottom to facilitate easy cleaning.
- F. External Bolts: Meter cover bolts shall be made of AISI Type 316 stainless steel. All other bolts shall be zinc-plated steel or stainless steel.
- G. Connections: Inlet and outlet flanges shall be rounded flanged per AWWA C207, Class D.
- H. Registers: Registers shall be permanently roll-sealed, straight reading in gallons. Registers shall include a center-sweep test hand and low flow indicator. Registers shall be removable for replacement without interruption of the service line.
- I. Register Boxes: Register boxes and covers shall be of bronze composition. The name of the manufacturer and the meter serial number shall be clearly identifiable and located on the register box covers.
- J. Register Box Sealing: The register box shall be affixed to the top cover by means of a plastic tamper-proof seal pin that must be destroyed in order to remove the register.
- K. Meter Serial Number: The meter serial number shall be on the meter flange or cover and on register box covers.
- L. United Measuring Element: A UME is a complete assembly, factory calibrated to AWWA Standards that include the cover, registers, and a turbine measuring element. It shall be easily field removable from the meter body without the requirement of unbolting flanges.
- M. Intermediate Gear Train: The intermediate gear train shall be directly coupled to the turbine rotor and magnetically coupled to the register through the meter cover. The gear train shall be housed within the turbine measuring chamber. All moving parts of the gear train shall be made of a self-lubricating polymer or AISI Type 316 stainless steel for operation in water.

- N. Bypass Meter: The bypass meter shall be of a positive displacement, nutating disc type. The bypass meter may be piped on the left or right side of the assembly. The bypass meter shall conform to AWWA C700 standards in the following sizes:

Mainline Size	Bypass Meter Size
4 inches	1 inch
6 inches	1-½ inches
8 inches	2 inches
10 inches	2 inches

- O. Automatic Valve
1. The automatic valve shall be of the spring-loaded, knuckle-joint type. All internal linkage parts shall be stainless steel. A vulcanized rubber disc on a stainless steel clapper plate shall seal against a bronze seat. The springs shall be AISI Type 18-8 stainless steel.
 2. The disc meter shall include a self-actuated valve that directs flow through the disc meter at low flow rates, and through the turbine meter at high flow rates. At high flow rates, the self-actuated throttle valve shall restrict the flow through the disc meter to minimize wear.
- P. Registration Accuracy: Registration accuracy over the normal operating range shall be 98.5% to 101.5%.
- Q. Acceptable meters shall be Neptune HP PROTECTUS[®] III or approved equal.
- R. To prevent cross connections, comply with the City’s “Cross Connection Control Policy and Program”.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Install meter in an 8’x 6’x 6’ pre-cast, reinforced concrete vault by Cloud Concrete or equal as shown in the City’s Standard Detail Drawing. The bottom of the meter assembly shall be located a minimum of 6-inches above the floor of the vault. The vault shall be installed in a grassed or landscape area. If no such area exists, upon prior approval from City Engineer, the vault may be placed in the edge of parking lots or sidewalk where only occasional wheel loadings may occur. In all instances the vault shall be protected from traffic. Such protections shall include concrete filled steel bollards or other approved method.
- B. Vault shall be self-draining by gravity sump or sump pump.

- C. Meter assembly shall include a bypass line.
- D. The vault shall include a 72" x 48" Halliday Products Model H2W7248 (H-20 wheel loading rated) Double Leaf aluminum access door with spring assist and lock. The hatches shall be offset to provide accessibility to the steps, as shown in the City's Standard Detail Drawing.
- E. Each installation shall have steps conforming to ASTM C478. The steps shall be made of copolymer polypropylene plastic conforming to the latest revision of ASTM D-4101 and shall have a ½-inch diameter Grade 60 Steel reinforcing rod meeting the latest revision of ASTM A615 through its center. Each step shall be 12 inches in width and capable of supporting a load of 1,000 pounds in the center of the step when projected 6 inches from the wall. Each step shall be equipped with non-skid grooves. Rung spacing shall be 12 inches. The location of the steps shall be coordinated with the access hatch offset so that the steps are easily accessible.
- F. Piping shall be ductile iron Class 350 with flanged ends inside the vault. All other joints and fittings shall be mechanically restrained (see Section 02713, Paragraph 3.09).
- G. Pipe and meter shall be adequately supported to prevent transmitting stress to meter or pipe. Concrete blocks or bricks stacked beneath pipe will not be acceptable.
- H. A post indicator valve, Mueller A20806, or approved equal shall be used between the valve pit and customer's building.
- I. The by-pass line shall include gate valve with locking top valve box Tyler Union Box 91-C or approved equal.
- J. Gate valves shall also be placed at the City main and on either side of the meter (just outside the pit)

END OF SECTION

SECTION 02722

SANITARY SEWER SYSTEMS

PART 1 – GENERAL

1.01 WORK INCLUDED

The work included in this Section includes the installation and testing of sanitary sewerage systems. All sanitary sewerage systems shall conform to the design and construction standards promulgated by the Tennessee Department of Environment and Conservation (TDEC).

1.02 RELATED WORK

- A. Section 02221: Trenching, Bedding and Backfilling
- B. Section 11200: Sewer Valves

1.03 DELIVERY, STORAGE AND HANDLING

Care shall be exercised in the delivery, storage and handling of all materials prior to their incorporation into the work. Follow all manufacturers' recommendations for delivery and storage (except where these specifications differ). Acceptance of questionable material shall be based solely on the City Engineer's interpretation of fabrication, delivery, storage and installation practices of the material in question.

PART 2 – PRODUCTS

2.01 GENERAL

New sanitary sewer pipe may generally be constructed of PVC pipe as specified in Paragraphs 2.02 and 2.03 of this Section, with the following exceptions:

- A. Sanitary sewers shall be specially coated and lined ductile iron pipe where indicated on the Contract Drawings.
- B. Open cut sanitary sewers crossing drainage ditches and swales, storm drain discharge, wet weather streams, USGS blue-line streams, and other erosive environments shall be specially coated and lined ductile iron pipe and will be provided with concrete encasement.
- C. Sanitary sewers with less than the required 36 inches of cover in non-traffic areas and 48 inches in areas subject to vehicular traffic shall be specially coated and lined ductile iron pipe.

- D. Sanitary sewers installed at depths greater than 20 feet shall be constructed of specially coated and lined ductile iron pipe.
- E. Where sanitary sewers are installed in new fill, a compaction letter sealed by a Geotechnical Engineer registered in the State of Tennessee shall be submitted to the Owner prior to accepting said utilities. An acceptable compaction letter shall state that field density testing indicates the fill has been compacted to at least 95% of the maximum dry density according to the Standard Proctor. If a compaction letter is not available, special protection such as replacement with ductile iron pipe with joint restraint shall be required.
- F. Where additional pipe protection is required due to loads, insufficient cover, erosive environments, crossing other utilities, etc., specially coated and lined ductile iron pipe, restrained joints, concrete encasement and other methods shall be required as directed by the City Engineer.
- G. Pipe material for sanitary sewers larger than 24 inches in diameter shall be determined on a case-by-case basis by the City Engineer.
- H. Sanitary sewer pipe installed by horizontal directional drilling shall be HDPE pipe unless otherwise approved by the City Engineer. See Section 02727 for product specifications of HDPE pipe.

2.02 POLYVINYL CHLORIDE (PVC) GRAVITY SEWER PIPE

- A. Manufactured from virgin, National Sanitation Foundation (NSF) approved resin conforming to ASTM D1784, suitable for use as a gravity sewer conduit with provisions for contraction and expansion at each joint, with a rubber ring and standard lengths of 20-feet and 12.5-feet plus or minus one (1) inch.
- B. Joints shall meet the requirements of ASTM D3212. Joint design shall be tested and certified to result in no leakage under prescribed laboratory test conditions of joint alignment, load conditions, pressure and vacuum, and deflection. Pipe and fittings shall have integral bell with elastomeric seal joint. The gaskets used for joining PVC sewer pipe shall conform to ASTM F477.
- C. PVC gravity sewer main pipe 8 inches to 15 inches in diameter shall meet and/or exceed the requirements of ASTM D3034, SDR 35. PVC gravity sewer pipe installed at depths greater than 12 feet shall conform to SDR 26.
- D. Large diameter PVC gravity sewer main pipe 18 inches to 30 inches in diameter shall meet and/or exceed the requirements of ASTM F679, SDR 35 or PS 46. PVC gravity sewer pipe installed at depths greater than 12 feet shall conform to SDR 26 or PS 115.
- E. Gravity sewer mains shall be at least 8 inches in diameter.
- F. All PVC gravity service line pipe and fittings from the sewer main to the sewer cleanout assembly shall conform to SDR 35 unless depth exceeds 12 feet, in which case service lines and fittings shall conform to SDR 26.

- G. Color of PVC gravity sewer pipe shall be green or white.
- H. All PVC gravity sewer pipe shall be clearly marked with the manufacturer's name, nominal diameter, SDR, ASTM designation, and NSF approval seal.

2.03 POLYVINYL CHLORIDE (PVC) PRESSURE SEWER PIPE AND FITTINGS

- A. Manufactured from virgin National Sanitation Foundation (NSF) approved resin, PVC 1120 made from PVC compounds 12454-A or 12454-B as defined in ASTM D1784.
- B. PVC pressure sewer pipe 4 inches to 12 inches in diameter shall meet and/or exceed the requirements of ASTM D2241, SDR 21, Pressure Class 200 or AWWA C900, DR14, Pressure Class 200. PVC pressure sewer pipe 14 inches to 24 inches in diameter shall meet and/or exceed the requirements of AWWA C905, DR18, Pressure Class 235.
- C. PVC pressure sewer pipe shall have bell and spigot push-on joints manufactured in accordance with ASTM D3139. The bell shall consist of an integral wall section with a solid cross-section elastomeric gasket securely locked in place to prevent displacement during assembly. The gasket shall be reinforced with a steel band or other rigid material and shall conform to ASTM F477. The gasket and annular groove shall be designed and shaped so that when the joint is assembled, the gasket will be radially compressed to the pipe and locked in place against displacement, thus forming a positive seal.
- D. Color of PVC pressure sewer pipe shall be green or white.
- E. All PVC pressure sewer pipe shall be clearly marked with the manufacturer's name, nominal diameter, type of material, SDR or Class, ASTM or AWWA designation, and NSF approval seal.
- F. All fittings for PVC pressure sewer mains shall be ductile iron with mechanical joints as described in Paragraph 2.04 of this section. The gaskets shall be duck-tipped transition gaskets for use with PVC pipe. All adaptors, fittings and transition gaskets necessary to connect ductile iron fittings to PVC shall be furnished.

2.04 DUCTILE IRON SEWER PIPE AND FITTINGS

- A. Ductile iron gravity sewer pipe shall conform to the latest revisions of ASTM A746, ANSI/AWWA C151/A21.51 and ANSI/AWWA C111/A21.11.
- B. Ductile iron pressure sewer pipe shall conform to the latest revisions of ANSI/AWWA C151/A21.51 and ANSI/AWWA C111/A21.11.
- C. Unless otherwise specified or shown on the Contract Drawings, ductile iron sewer pipe shall be Pressure Class 350 for sizes 12-inch and smaller. Sizes 14-inch and larger shall be Pressure Class 250.

- D. Unless otherwise specified or shown on the Contract Drawings, ductile iron sewer pipe shall be furnished with push-on joints, with mechanical joint fittings and valves. Exposed piping shall be flanged.
- E. Ductile iron sewer pipe shall be specially coated and lined as detailed in Paragraph 2.05 of this Section.
- F. All pipe shall be new and shall have the manufacturer's name, AWWA or ASTM designation, weight, pressure class and nominal diameter stamped on the outside of each pipe.
- G. Standard and special fittings shall be mechanical joint ductile iron fittings meeting the requirements of ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53, as applicable. Fittings shall have a pressure rating of 350 psi for 24-inch and smaller piping. Fittings shall at a minimum have the same pressure rating as the connecting pipe. Ductile iron fittings shall be specially coated and lined as detailed in Paragraph 2.05 of this Section.

2.05 SPECIAL COATINGS AND LININGS FOR DUCTILE IRON PIPE AND FITTINGS

- A. All ductile iron pipe and fittings shall be coated outside with a minimum 1 mil-thick bituminous coating per AWW C151 for ductile iron pipe, AWWA C115 for flanged pipe and AWWA C110 and C153 for fittings.
- B. All ductile iron pipe and fittings shall be lined with 40 mils nominal dry film thickness of "Protecto 401 Ceramic Epoxy." The lining material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment.
- C. Lining application shall be performed by an applicator approved by the coating manufacturer, in accordance with the manufacturer's instructions and under controlled conditions at the applicator's shop or the pipe manufacturer's plant.
- D. All ductile iron pipe and fitting linings shall be inspected in accordance with the manufacturer's recommendations. The pipe or fitting manufacturer shall submit a certified affidavit of compliance with the manufacturer's instructions and requirements specified herein.

2.06 JOINT RESTRAINT DEVICES

- A. Mechanical Joint Restraint Devices
 1. All mechanical joint fittings and valves shall be restrained at each opening with approved mechanical joint restraint devices. Restrained fittings **do not** eliminate or replace the requirement for sufficient concrete thrust blocking and/or restrained pipe joints.
 2. Restraint devices for joining plain end pipe to mechanical joint fittings, pipe and valves shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C111/A21.11 for PVC pipe or ANSI/AWWA C110/A21.10 for ductile iron pipe.
 3. Devices for PVC pipe shall have a working pressure rating equal to that of the pipe on which it is used. Ratings are for water pressure and must include a minimum safety factor of 2:1.

4. Devices for ductile iron pipe shall have a working pressure rating of 350 psi for 3 to 16 inch and 250 psi for 18 inch and larger. Ratings are for water pressure and must include a minimum safety factor of 2:1.
5. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536.
6. Mechanical joint restraint shall require conventional tools and installation procedures per AWWA C600, while retaining full mechanical joint deflection during assembly as well as allowing joint deflection after assembly. Proper actuation of the gripping wedges shall be ensured with torque limiting twist off nuts.
7. Mechanical joint restraint shall be Megalug Series 2000PV or Megalug Series 1100 produced by EBAA Iron Inc. or approved equal.

B. Bell Restraint Harness Devices

1. Bell restraint harnesses for push-on joint PVC pipe shall be Series 1600, 2800, or 6500 as manufactured by EBAA Iron, Inc., Series 1350 or 1390 by Uni-Flange, or approved equal.
2. Bell restraint harnesses for push-on joint ductile iron pipe shall be Series 1700 by EBAA Iron, Inc., or approved equal.

2.07 COMPRESSION COUPLINGS

- A. When joining together dissimilar types of pipe, such as PVC and vitrified clay pipe, for repairing and rejoining sections of gravity sewer, for joining new pipe to existing pipe, and for connecting the first full joint of pipe to a short stub through a manhole wall, compression couplings complying with ASTM C425 shall be used.
- B. Compression couplings shall be resistant to corrosion by soil and sewage and shall provide a permanent watertight joint. The compression couplings shall be of natural or synthetic rubber or rubber-like material and the bands for attaching the couplings shall be of stainless steel.

2.08 PRECAST CONCRETE MANHOLES

- A. All precast concrete manholes shall conform to the requirements of AASHTO M-199 SR and ASTM C478, including steel reinforcement.
- B. All concrete used in connection with the construction of precast manholes shall be at minimum 4,000 psi concrete.
- C. The precast manufacturer shall use XYPEX additive. XYPEX ADMIX C-1000/dye shall be added to the concrete during batching at a rate of 2-3 percent by weight of Portland cement. The amount of cement shall remain the same and not be reduced. Precast concrete structures shall have a reddish tint to verify the XYPEX admix.
- D. Base, riser and top sections shall have tongue and groove joints.
- E. The Contractor may choose to order new precast base sections with monolithic bottoms and inverts already formed and manhole bases and risers with pipe openings and integrally cast resilient pipe connectors in place. Manhole steps may also be provided cast-in-place. It shall be the Contractor's responsibility to provide manholes with properly located and sized pipe

openings and properly formed inverts. Manholes not constructed in accordance with the Contract Drawings are subject to rejection and replacement at no additional cost to the Owner.

- F. Unless otherwise specified, all manholes shall have an inside diameter of not less than 4 feet and a vertical wall height of not less than 30 inches. Drop manholes shall be a minimum of 5 feet in diameter and 6-foot diameter manholes shall be used on sewers 30 inches and larger.
- G. Top sections shall be eccentric cones where cover over the pipe exceeds 4 feet. Top sections shall be flat top where cover over the pipe is 4 feet or less.
- H. The clear opening in the manhole shall be not less than 24 inches. 30-inch diameter openings may be required at the City Engineer's discretion in special circumstances such as shallow manholes less than 4 feet deep or manholes on large diameter trunk sewers.
- I. All manholes with drop assemblies or force main entrances shall be epoxy coated or utilize an interior construction such as the A-Lok® system to prevent H₂S deterioration of the manhole interior.

2.09 MANHOLE INVERTS

Manhole inverts shall be constructed of concrete with a minimum 28-day compressive strength of 3,000 psi. Inverts shall be shaped so as to form a smooth, even U-shaped channel with curves formed with as large a radius as is permitted by the size of the manhole. The height of the channel shall be at least ½ the pipe diameter for pipes less than 15 inches in diameter and at least ¾ the pipe diameter for pipes 15 inches in diameter and larger. The bench shall be sloped to drain to the channel, but no more steeply than a slope of 1 in 12.

2.10 JOINT SEALANT FOR PRECAST MANHOLES AND WET WELLS

Joint sealant for precast manholes and wet wells shall provide permanently flexible, watertight joints, shall retain workability over a wide temperature range, shall form permanent bonds to concrete substrates and shall not shrink, harden or oxidize upon aging. Joint sealant material shall consist of pre-molded rubber or butyl rubber. Sealants shall meet the requirements of Federal Specification SS-S-210A and AASHTO M-198.

2.11 CASTINGS FOR FRAME AND COVERS

- A. Castings shall be gray cast iron conforming to the requirements of ASTM A48, Class 30. Castings shall be made accurately to the required dimensions, shall be sound, smooth, clean, free from scale, lumps, blisters and other defects. Castings shall be machined to provide solid bearing so that covers rest securely in the frames with no rocking.
- B. Castings shall be thoroughly cleaned before rusting begins and coated with bituminous paint that will produce an acceptable finish that is not affected by exposure to hot or cold weather.
- C. Standard frames and covers shall be traffic duty weighing not less than 410 pounds and shall have a minimum 24-inch clear opening. The covers shall be the solid indented type with no holes except watertight pick notches, with the words "SANITARY SEWER" cast in raised letters

thereon. Standard manhole frames and covers shall be John Bouchard & Sons No. 1155 or approved equal.

- D. Watertight frames and covers shall be traffic duty weighing not less than 485 pounds and shall be the double cover type with rubber gaskets. The surface cover shall be the solid type with no holes except watertight pick notches, with the words "SANITARY SEWER" cast in raised letters thereon. The inner cover shall be of the solid type with no holes, shall have not less than two lifting handles and shall have a neoprene sealing gasket with at least 3/8-inch diameter cross section. The inner cover shall be mechanically sealed by means of a removable steel locking bar located over the inner cover with a centrally located stainless steel tightening bolt. This bolt shall be fitted for a tee-handle or bent-handle that shall be included with each cover. The bolt shall have ACME threads for durability. The inner cover shall have appropriate reinforcing ribs to prevent cracking or distortion when tightened. The inner cover shall have sufficient clearance to allow easy installation of the cover. Watertight manhole frames and covers shall be John Bouchard & Sons No. 1123 or approved equal.
- E. Covers shall include the City logo where directed by the City Engineer. Covers bearing the City logo shall be furnished for all projects in the downtown Clarksville area.
- F. Covers shall be bolted to the frame where indicated on the drawings or as otherwise specified.
- G. Frame shall be bolted to the precast concrete section with four, ½-inch diameter expansion anchor bolts.
- H. Castings with 30-inch openings may be used in special circumstances such as shallow manholes less than 4 feet deep or manholes on large diameter trunk sewers. Refer to City Engineer for these special applications.

2.12 MANHOLE STEPS

- A. Manhole steps conforming to ASTM C478 shall be made of copolymer polypropylene plastic conforming to the latest revision of ASTM D-4101 and shall have a ½-inch diameter Grade 60 Steel reinforcing rod meeting the latest revision of ASTM A615 through its center.
- B. Each step shall be 12 inches in width and capable of supporting a load of 1,000 pounds in the center of the step when projected 6 inches from the wall. Each step shall be equipped with non-skid grooves. Rung spacing shall be 12 inches.

2.13 RESILIENT PIPE CONNECTIONS AT MANHOLES

- A. Resilient pipe connectors shall be manufactured in accordance with ASTM C923 and shall provide a positive watertight joint and minimum of 10 degrees deflection in any direction. There shall be no water leakage through the connector when pipe is in its maximum deflected position. Connectors shall be manufactured of durable rubber, which offers superior resistance to water, sewage, oils, acid, ozone, weathering and aging. Connectors shall be securely sealed to the cut out in the manhole wall by means of stainless steel expansion sleeves, bands or rings and to the pipe by means of stainless steel clamps or bands. Connectors shall be KOR-N-SEAL as manufactured by NPC, Inc., or approved equal.

- B. Compression-type connectors cast integrally into the manhole wall shall be A-Lok or equal.
- C. When making a main or service connection to an existing manhole or to any manhole for which a factory installed booted opening has not been provided, a hole shall be cored into the manhole with minimal damage to the structure and a resilient pipe connector such as KOR-N-SEAL installed.
- D. When setting a manhole over an existing sewer line, the exterior of the pipe shall be thoroughly cleaned and a double wrap of Ram Neck or equivalent bitumastic material placed around the pipe to form a gasket over which the concrete for the new manhole base is poured, in order to form a watertight connection.

2.14 MANHOLE FRAME SEALS

- A. Frame seals shall consist of a flexible internal rubber sleeve, interlocking extensions and stainless steel expansion bands as manufactured by Cretex Specialty Products or pre-approved equal. Frame seals shall be installed in areas designated by the City Engineer.
- B. The seal shall remain flexible throughout a 25-year design life, allowing repeated vertical movement of the frame of not less than 2 inches and/or repeated horizontal movement of not less than ½ inch. The sleeve portion of the seal shall be double, triple, or quadruple pleated with a minimum unexpanded vertical height of 8 inches, 10 inches, or 13 inches respectively. The sleeve and extension shall have a minimum thickness of 3/16 inches and shall be made from a high quality rubber compound conforming to the applicable material requirements of ASTM C923, with a minimum 1500 psi tensile strength, a maximum 18% compression set and a hardness (durometer) of 48±5. The area of the seal that compresses against the manhole frame/casting and the chimney/cone shall have a series of sealing fins to facilitate a watertight seal. These sealing fins shall have teardrop holes or air pockets to allow the sealing area to conform to minor surface irregularities that may be encountered.
- C. The expansion bands used to compress the sleeve against the manhole shall be integrally formed from 16-gauge stainless steel conforming to the applicable portion of ASTM C-923, Type 304, with no welded attachments, and shall have a minimum width of 1¼ inches.
- D. The bands shall have a minimum adjustment range of 2-½ diameter inches and the mechanism used to expand the band shall have the capacity to develop the pressures necessary to make a watertight seal. The band shall be permanently held in this expanded position by the positive locking mechanism located on the overlapping edge of the band.

2.15 MANHOLE ENCAPSULATION SYSTEM

Manhole encapsulation systems may be required in special circumstances such as manholes within 100-year flood plains. Where required, the manhole encapsulation system shall consist of a heat-shrinkable wrap that is installed on the outside surface of all joints including the manhole casting to manhole connection. The wrap shall be a minimum width of 12 inches and shall be installed in accordance with the manufacturer's recommendations. The encapsulation system shall be WrapidSeal as manufactured by Canusa or equal.

2.16 SEWER PUMP STATIONS

- A. New pump stations and force mains are not allowed if the development can be served by the extension of gravity sewer. Where approved for use, the Developer's Engineer shall submit pump curves, operational data, flow projections and hydraulic calculations for review. Where a development is to be constructed in phases, master planning of a subdivision will be required to assure that the number of lift stations is kept minimal and that lift station facilities are abandoned as adjacent phases are constructed or adjacent property is developed.
- B. The Developer shall provide a permanent dedicated site for the pump station and its access road to be owned by the City of Clarksville. A quick claim deed shall accompany the final plat before signature by the City Engineer.
- C. Acceptable pumping systems include the following:
 - 1. Grinder/E-One
 - 2. Suction Lift
 - 3. Submersible
- D. Pump Station Site Requirements
 - 1. Sewage pump stations should be located as far as practicable from present or proposed built-up residential areas and shall be installed in a prepared, landscaped, and fenced area. Noise control, odor control, and station architectural design should be taken into consideration.
 - 2. The area for the pump stations shall be large enough to accommodate odor control equipment, pump trucks and the placement of a generator if necessary. Sites for stations shall be of sufficient size for future expansion or addition, if applicable. At a minimum, the pump station site shall measure approximately 30'x30' for suction lift pump stations and approximately 60'x60' for submersible pump stations, not including access road.
 - 3. The site shall be graded to provide satisfactorily drainage such that the lift station and its access drive will not be inundated during storm events. The top of the lift station wet well shall be 2 feet above the 100-year flood level and shall also be at least 6 inches above surrounding grade elevation. Drainage swales shall be rip-rapped or otherwise protected against erosion.
 - 4. The access road to the lift station shall be constructed at a grade not to exceed 13 percent and shall be paved. The typical required pavement section will consist of 6 inches of compacted crushed stone base course and 2 inches of asphalt. Prior to placement of pavement materials, the access road shall be proof-rolled using a fully loaded dump truck in the presence of a representative of the City and any unstable areas undercut and replaced. The access road shall not be shared with residential driveways.
 - 5. The pump station yard shall be graveled with 6 inches of crushed stone gravel, paved with asphalt, or landscaped with a grass lawn as indicated on the Contract Drawings.
 - 6. At a minimum, the pump station site shall be enclosed by a chain link fence and gate in accordance with Section 02821. A privacy fence may be required where the pump station is located near residences. Landscaping may be required as a buffer to properties adjacent to the proposed lift station. Noise control, odor control, and station architectural design shall be considered and included on the Contract Drawings.

E. Wet Well Sizing

1. A suitable wet well shall be provided for each sewer lift station. The wet well shall be of sufficient size to permit proper operation of the lift station while minimizing the probability of an overflow event.
2. Pre-cast concrete wet wells shall have a minimum inside diameter of six (6) feet.
3. All wet wells shall be sized to provide sufficient capacity to retain a minimum of 2 hours of average flow as measured from the pump cutoff level to the invert of the lowest inlet pipe. Storage volumes from sewer main and associated manholes may also be considered, as well as wet well storage above the lowest invert, provided that Developer's Engineer can demonstrate that overflow and/or service line backup into connected properties will not occur.
4. The Developer's Engineer shall also consider future growth within the lift station drainage basin during sizing of the lift station.

F. Wet Well Materials

1. The wet well must be constructed of materials to prevent deterioration from acids formed from H₂S and other chemicals observed or expected for the operating conditions anticipated in the new wet well.
2. The preferred materials of construction include pre-cast concrete or formed concrete. Pre-cast concrete wet wells shall conform to the requirements of AASHTO M-199 SR and ASTM C478, including steel reinforcement. All concrete used in connection with the construction of precast manholes shall be at minimum 4,000 psi concrete.
3. The precast manufacturer shall use XYPEX additive. XYPEX ADMIX C-1000/dye shall be added to the concrete during batching at a rate of 2-3 percent by weight of Portland cement. The amount of cement shall remain the same and not be reduced. Precast concrete structures shall have a reddish tint to verify the XYPEX admix.
4. Fiberglass, HDPE and coated steel wet wells are acceptable for use in pre-fabricated or "canned" lift stations where approved by the City Engineer. Fiberglass or coated steel lift stations shall be certified by the manufacturer and accompanied by a warranty against deterioration.

G. Wet Well Construction

1. Wet well penetrations shall be mechanically sealed with resilient pipe connectors as specified in Paragraph 2.13 of this Section.
2. Joint sealant for precast wet wells shall comply with Paragraph 2.10 of this Section.
3. All external wet well joints shall be sealed using a wrap seal such as CANUSA Wrapidseal® or equivalent to prevent infiltration or inflow at the joint(s), as specified in Paragraph 2.15 of this Section.
4. Wet well bottoms shall be constructed with a minimum of a 4-inch, 45° fillet at wall joints to prevent solids accumulation.
5. Access steps for wet wells will not be allowed. At the Engineer's direction, a fiberglass reinforced plastic (FRP) ladder with approved fall-protection devices shall be installed.
6. Anti-flotation collars shall be installed where groundwater is present or expected to be present above the bottom of the lift station during dry or wet seasons.
7. Access hatches for submersible wet well applications shall be supplemented with a lockable secondary 1-inch thick aluminum grating panel, such as the Halliday Products Retro-Grate. The grating panel shall be hinged and shall be supplied with a positive latch to maintain unit in an upright position. A 6-inch viewing area shall be provided

on each lateral unhinged side of grating panel for visual observation and limited maintenance procedures.

- H. Station piping shall be specially lined and coated, flanged ductile iron pipe. Buried piping to the common force main shall be specially lined and coated mechanical joint ductile iron pipe.
- I. Consideration shall be given during inlet design to minimize flow turbulence that accelerates release of trapped gases in the flow stream. Baffles, interior drop assemblies or other methods may be required. The number of inlet pipes into the wet well should be minimized.
- J. In areas where sanitary sewers drain to a wastewater pumping station, an approved backwater valve shall be installed in all buildings subject to flooding during a failure of the pumping facilities. The location of said backwater valve shall be as indicated on the drawing for a typical house connection or as directed by the City Engineer.
- K. Appropriate valves, valve vaults and valve boxes shall be installed in accordance with the Contract Documents.
- L. Pressure gauges are required on the discharge piping of all suction lift and submersible pump stations. Flow meters shall be installed on the common discharge pipe within a concrete vault for all pump stations with rated flows of 400 gpm and greater, as specified in Section 13310.
- M. Suction-lift and submersible pump stations shall be equipped with a dual level sensor system, which shall consist of a pressure transducer with a float back-up system. Sensors should be located so as not to be affected by the flows entering the wet well or by the suction of the pumps.
- N. All electrical wiring shall be copper conductor. Aluminum is not an acceptable substitute.
- O. All control and instrument panels shall be supported by galvanized steel posts set in concrete. Wooden posts are not acceptable.
- P. To prevent potential settling damage, a suitable length of flexible conduit shall be used to connect rigid conduit to the lift station.
- Q. A riser from the force main with quick connect capabilities and appropriate valving shall be provided for all lift stations with rated pump flows of 50 gpm or greater. Quick connects shall be as specified in Section 11200.
- R. An alarm system should be provided for all pumping stations as specified in Section 13310.
 - 1. For lift stations with rated pump flows less than 400 gpm, a cell phone-based telemetry (or cellemetry) system shall be installed.
 - 2. For lift stations with rated pump flows of 400 gpm or greater, real-time SCADA systems shall be installed.
 - 3. A backup power supply, such as a battery pack with an automatic switchover feature, should be provided for the alarm system, such that a failure of the primary power source will not disable the alarm system.
 - 4. Test circuits should be provided to enable the alarm system to be tested and verified that it is in good working order.

PART 3 - EXECUTION

3.01 WATER AND SEWER LINE SEPARATION

- A. Maintain a 10-foot horizontal separation, measured edge to edge, between any new or proposed sanitary sewer and any existing or proposed water main.
- B. Where conditions cause the required horizontal separation to be impractical, the sewer may be laid closer provided it is laid in a separate trench and the elevation of the top of the sewer is at least 18 inches below the bottom of the water main.
- C. Where a sewer crosses under a water main, the top of the sewer shall be at least 18 inches below the bottom of the main.
- D. Where conditions cause the required vertical separation to be impractical, the water main shall be relocated to provide the required separation or else reconstructed with mechanical joint ductile iron pipe for a distance of 10 feet on each side of the sewer with a full joint of the water main centered over the sewer.
- E. Where sewers must be constructed over water mains or less than 18 inches below the water main, the sewer shall be designed and constructed equal to water main standards and pressure tested to assume water tightness.
- F. Additional protection such as concrete encasement shall be installed where directed by the Engineer.
- G. To prevent cross connection, comply with the City's "Cross Connection Control Policy and Program."

3.02 GRAVITY SEWER INSTALLATION

- A. Properly excavate trench to required lines and depths and install any necessary sheeting, shoring and bracing in accordance with Section 02221.
- B. Prepare a satisfactory trench bottom and install suitable bedding in accordance with Section 02221.
- C. Lay pipe true to the lines and grades from the grade and alignment stakes, or equally usable references.
- D. Carefully inspect all pipe and each fitting prior to its placement in the trench, and reject and remove any damaged or defective pipe or fitting from the job site.
- E. Dig bell holes large enough to allow ample room for the pipe joints to be properly made. Carefully grade the crushed stone bedding between bell holes such that each pipe barrel will rest for its entire length upon the prepared bedding to assure uniform support of the pipe.

- F. Lay pipe progressively up grade, with bell upstream in such a manner as to form close, concentric joints with smooth bottom inverts. Swab the interior of the pipe to remove all foreign material. Prepare the bell and remove undesirable material from the gasket and gasket recess. Joining of all pipe shall be in accordance with manufacturer's specifications.
- G. When cutting short lengths of PVC pipe, a pipe cutter will be used, and care shall be taken to make the cut at right angles to the centerline of the pipe. In the case of push-on pipe, the cut ends shall be tapered with a portable grinder or course file to match the manufactured taper.
- H. Compression couplings shall be used where indicated on the Contract Drawings or as specified in Paragraph 2.07 of this Section.
- I. Gravity sewer pipe shall be of the size and material indicated on the Contract Drawings and as specified in Part 2 of this Section. No sewer main shall be less than 8 inches in diameter.
- J. Gravity sewer pipe shall be installed at the grade indicated on the Contract Drawings. Sewer pipe shall be installed with slopes equal to or exceeding the minimum slopes provided in the following table.

Nominal Sewer Size	Minimum Slope in Feet Per 100 Feet
8 inch	0.40
10 inch	0.28
12 inch	0.22
14 inch	0.17
15 inch	0.15
16 inch	0.14
18 inch	0.12
21 inch	0.10
24 inch	0.08
27 inch	0.067
30 inch	0.058

- K. Sewer service assemblies shall be installed with the sewer main as it is being laid where indicated on the Contract Drawings and in accordance with Paragraph 3.03 of this Section.
- L. Additional pipe protection such as use of specially lined ductile iron pipe or concrete encasement shall be installed where indicated on the Contract Drawings or as directed by the Engineer. Pipe protection may be required for shallow sewers, areas subject to erosion, very heavy traffic, utility crossings, along property lines where future fence posts could be anticipated, etc.
- M. Sewers on 18 percent slope or greater shall be anchored securely with concrete anchors or equal. Minimum anchorage spacing is as follows:
 1. Not over 36 feet center to center on grades 18 percent and up to 24 percent.
 2. Not over 24 feet center to center on grades 25 percent and up to 34 percent.
 3. Not over 16 feet center to center on grades 35 percent and over.
- N. As the work progresses, thoroughly clean the interior of the pipe in place. After each joint of pipe has been laid, carefully inspect it and remove all foreign material from its interior. Upon

completion of a section between any two manholes, it shall be possible to view a complete circle of light when looking through the pipe.

- O. Do not allow walking on complete pipelines until backfill has been placed to a depth of at least 6 inches above the crown of the pipe.
- P. When laying pipe ceases at the end of the workday or any other disruption, close the open ends of the pipe with a suitable watertight plug to prevent the entrance of foreign materials.
- Q. Trench backfill and check dams shall be placed in accordance with Section 02221.
- R. Make connections to existing manholes by core drilling a hole in the wall of the existing structure, installing a resilient pipe connector such as Kor-N-Seal, and securing the sewer pipe in the connector in accordance with the manufacturer's recommendations. Shape or re-shape the invert of the manhole to accommodate the new flow channel.
- S. Measurement of the depth to determine depth classification shall be the vertical distance between the original ground surface elevation and the invert of the pipe as shown on the Contract Drawings except where the profile has been revised and approved by the Owner.

3.03 SEWER SERVICE ASSEMBLY INSTALLATION

- A. The standard sewer service connection shall be 4 inches in diameter unless shown otherwise on the Contract Drawings and shall connect to the sewer main at a tee or wye connection installed with the sewer main as it is being laid. The service fitting shall be of the same material as the sewer main pipe.
- B. Sewer service connections into manholes are discouraged and shall not be made unless specifically approved by the City.
- C. Connection to an existing sewer main where no service fitting has been installed shall, with the approval of the City, be accomplished by a service tap to the sewer main through a tapping saddle. The saddle shall be a gasketed saddle secured to the sewer main by at least two stainless steel clamps. Tapping saddles shall be approved for connections to existing sewer lines only.
- D. Where specifically approved by the City, connections to an existing main may be accomplished using Inserta Tee® Fittings as an alternative to tapping saddles. Inserta Tee® Fittings shall be installed on the top of the main or at a 45-degree angle from the top of the main. Inserta Tee® Fittings shall be installed in accordance with manufacturer recommendations.
- E. Where sewer service connections are 8 feet in depth or greater, sewer risers shall be installed at the service connection to protect the service connection and to facilitate excavation of the sewer lateral. Deep sewer risers shall be by Bates & Harrington, Inc., of Madison Heights, VA or equal.
- F. The Contractor shall stub a capped service pipe from the service connection to a point approximately 3 feet onto a customer's property across the Right-of-Way or easement line,

with the exception that a minimum of one 13-foot joint shall be installed. Service stubs from manholes, where allowed, shall be a minimum of one 13-foot joint.

- G. Service pipe shall be of the same material as the sewer main and shall be bed accordingly. The minimum grade on service pipe shall be 1% or 1/8" per foot. The service stub shall be plugged, backfilled and marked at the plugged end.
- H. The end of each lateral stub shall be marked with a 6-foot long 4x4 wooden post or metal fence post embedded 2 feet into the ground and be marked with green paint.
- I. Identifying tape shall be installed in accordance with Paragraph 3.09 of this Section.
- J. The contractor shall stamp the curb with an "S" where sewer services are located.
- K. It shall be the residential plumber's responsibility to install a sewer cleanout at the Right-of-Way or easement line. Cleanout assemblies shall be constructed of Schedule 40, solvent weld pipe. The cleanout shall consist of a sanitary tee (sweep), vertical pipe or appropriate length, and a threaded cleanout plug. All property line cleanouts shall be installed inside a polyethylene box measuring 9 inches in diameter and 12 inches deep. The cover shall be of cast iron and labeled "Sewer." Cleanout boxes and covers are issued by the City of Clarksville.

3.04 PRECAST CONCRETE MANHOLE INSTALLATION

- A. Manholes shall be installed at the end of each sewer main, at all changes in grade, size, or alignment, at all intersections, and at distances not greater than 400 feet for sewers 16 inches or less and 500 feet for sewers larger than 16 inches. Where a sewer main extension is expected in the foreseeable future, the manhole shall be installed at least to the property line shared by the current and future development.
- B. Provide a stable, satisfactory subgrade for the new manhole. Dewater the excavation as required. Any unstable or otherwise unsuitable material encountered at the subgrade shall be undercut and replaced with compacted Class I angular material.
- C. Provide a bedding of at least 6 inches of compacted Class I angular material as crushed stone base material for the manhole.
- D. Manholes shall be installed such that they are fully and uniformly supported, set plumb in true alignment and at the proper grade in accordance with the Contract Drawings.
- E. Where concrete foundations are to be cast-in-place, the concrete shall have a compressive strength of at least 4,000 psi. The base section shall be carefully blocked above the prepared base stone so that it is plumb and in true alignment and the concrete foundation poured beneath it. The concrete foundation shall be at least 8 inches thick. Riser sections shall not be added until the concrete foundation has been allowed to set for at least 24 hours.
- F. Concrete anti-flotation collars shall be installed as sized and where indicated on the Contract Drawings, or where directed by the Engineer, to prevent flotation due to groundwater.
- G. Seal joints between sections with an approved joint sealant.

- H. Where pipe openings and integrally cast resilient pipe connectors have not been provided complete, the Contractor shall make connections to manholes by core drilling a hole in the wall of the structure, installing a resilient pipe connector such as Kor-N-Seal, and securing the sewer pipe in the connector in accordance with the manufacturer's recommendations. Shape the invert of the manhole to accommodate the flow channel as specified herein.
- I. Thoroughly wet and then completely fill all lift holes, any defects and all interior joints with non-shrink grout and smooth them to ensure watertightness.
- J. Where indicated on the Contract Drawings, the manhole encapsulation system shall be installed on the outside surface of all joints including the manhole casting to manhole connection. The manhole and casting shall be clean and dry prior to application of a primer as recommended by the manufacturer. Installation shall be in accordance with the manufacturer's recommendations.
- K. Trench check dams shall be installed upstream of each manhole as specified in Section 02221, Paragraph 3.13.
- L. Backfill manholes in accordance with the requirements for trenching and backfilling as specified in Section 02221, Paragraph 3.12.
- M. When completed, the manhole shall be free from channel obstructions and leakage.
- N. All manhole inverts shall be finished with mortar to provide a smooth transition from the manhole into the pipe entrances and exits.
- O. Measurement of the depth to determine depth classification shall be the vertical distance from the finished casting elevation to the invert of the outlet pipe as shown on the Contract Drawings unless the profile has been revised and approved by the Owner.

3.05 MANHOLE FRAME AND COVERS INSTALLATION

- A. All castings shall be of the types, dimension, and weights as shown on the Contract Drawings and as specified in Paragraph 2.11 of this Section and shall be set at the required elevation. Bolted watertight manhole covers are required in areas subject to flooding. Bolted down covers are also to be installed in all unimproved areas such as wooded areas that are subject to unsupervised vandalism.
- B. The manhole sidewall shall be adjusted with either steel or concrete grade adjustment rings as required to bring the casting to the required grade. No more than 6 inches of grade adjustment rings will be permitted on newly constructed manholes.
- C. Where manholes are constructed in paved areas, the frame and cover shall be tilted so as to conform to the exact slope, crown and grade of the existing adjacent pavement.
- D. A full circle of an approved joint sealant shall be placed between the manhole ring frame and the masonry portion of the manhole to assure water tightness. The frame shall be further secured to the manhole by the use of mortar or grout placed from the outside edge of the

masonry structure to a point approximately 1 inch below the top of the casting. Manhole frames shall be bolted to the manhole using four ½-inch diameter stainless steel expansion anchor bolts.

- E. Manhole frame seals shall be installed on sanitary manholes in accordance with the manufacturer's recommendations where indicated on the Contract Drawings or as directed by the City Engineer.
- F. Existing manhole frames shall be adjusted utilizing John Bouchard & Sons, Inc. manhole adjusting riser rings.

3.06 MANHOLE STEP INSTALLATION

Where not provided already cast-in-place in new precast manhole sections, set manhole steps at intervals of 12 inches along the wall of the manhole. Manhole steps shall be vertically aligned in each section of the manhole. In precast manholes, the holes left to receive the steps shall be mortared smooth following placement of the steps. The treads of the steps shall be free of mortar or other material when the manhole is completed.

3.07 DROP ASSEMBLY INSTALLATION

- A. Drop assemblies are also required in pump station wet wells where the difference between the invert elevation of the inlet pipe and the level control cutoff point is greater than 24 inches. Down pipes shall be terminated approximately 3 inches above the level control cutoff point.
- B. Drop assemblies shall be internal to the manhole or wet well. External drops shall not be permitted unless specifically approved by the Owner.
- C. Drop assemblies shall be constructed of PVC. The down pipe shall be 12 inches in diameter. A cross fitting shall be provided at the pipe entrance to the manhole to provide access for cleaning blockages. Stainless steel straps and anchors spaced no greater than 6 feet apart shall be installed to support the assembly. A 90 degree sweeping elbow shall be installed at the bottom of the drop pipe and a suitable invert shall be formed.
- D. Drop manholes shall be a minimum of 5 feet in diameter. All manholes with drop assemblies shall be epoxy coated or utilize an interior construction such as the A-Lok® system to prevent H₂S deterioration of the manhole interior.

3.08 SEWER FORCE MAIN INSTALLATION

- A. Properly excavate trench to required lines and grades and install any necessary sheeting, shoring and bracing in accordance with Section 02221.
- B. Prepare a satisfactory trench bottom in accordance with Section 02221, Paragraph 3.10.
- C. Lay the force main true to the lines and grades indicated on the Contract Drawings. Particular care shall be taken to assure the line is maintained on a positive or negative grade and that increased depth is provided where indicated on the Contract Drawings so that no undesired

local high point is created. The Contractor shall relay any force main pipe with undesired high points at no additional expense to the Owner.

- D. Unless otherwise directed by the Engineer, lay pipe with the bell ends facing the direction of laying.
- E. Carefully inspect all pipe, valves and fittings prior to placement in the trench, and reject and remove any damaged or defective pipe from the job site.
- F. Dig bell holes large enough to allow ample room for the pipe joints to be properly made. Carefully grade the bottom of the trench between bell holes such that each pipe barrel will rest for its entire length upon the trench bottom to assure uniform support of the pipe.
- G. All pipe and fittings shall be carefully lowered into the trench to prevent damage to the materials and to any protective coatings and linings. Specially lined ductile iron pipe and fittings must be handled only from the outside. No forks, chains, hooks, timber, etc. shall be placed inside the pipe and fittings for lifting, positioning or laying.
- H. The interior of all pipe, valves and fittings shall be thoroughly cleaned to remove any accumulated mud, debris, etc. before being laid. The spigot end shall be cleaned and the bell cleaned and prepared. If the pipe cannot be laid without allowing earth and debris from entering the pipe, a suitable cover such as canvas or a plug shall be used to assure the pipe remains clean until it is joined to the next pipe. Joining of all pipe shall be in accordance with the manufacturer's recommendations.
- I. Cut pipe for inserting valves, fittings, etc. in a neat and workmanlike manner without damaging the pipe. Follow the manufacturer's recommendations concerning how to cut and machine the pipe in order to leave a smooth end at right angles to the axis of the pipe. Hone the pipe with suitable tools to provide a smooth beveled edge on field cut sections.
- J. When pipe laying ceases at the end of the workday or any other disruption, such as inclement weather, close the open ends of the pipe with a suitable watertight plug or wrap to prevent entrance of foreign materials.
- K. Wherever pipe must be deflected from a straight line, the amount of deflection shall not exceed that necessary for the joint to be satisfactorily made. The deflection shall in no case exceed that recommended by the pipe manufacturer.
- L. At high points on the line profile, where a change from a positive to a negative grade occurs, an air relief or combination air/vacuum relief valve shall be installed as specified in the Contract Drawings and in Section 11200.
- M. Force main valves shall be installed where indicated on the Contract Drawings. Valves and stems shall be installed plumb and in accordance with Section 11200.
- N. All valves and fittings are to be restrained with mechanical joint restraining devices. These restraining devices **do not** eliminate the requirement for sufficient concrete thrust blocking and/or restrained joint pipe. The distance from the fitting to the end of the restraint shall not be less than that indicated on the Contract Drawings.

- O. Concrete thrust blocks shall be installed at all fittings in accordance with the Contract Drawings. The concrete shall be Class B concrete as specified in Section 03300. The thrust block shall be constructed between the fitting and undisturbed soil with a bearing area at least the size indicated on the Contract Drawings, and shall be constructed such that the fittings, valves and joints are accessible for repairs. All pipe, fittings and valves that will be in contact with the concrete shall be lubricated to prevent bonding with the thrust block.
- P. Backfill shall be as specified in Section 02221, Paragraphs 3.11 and 3.12.
- Q. Carsonite markers shall be installed where indicated on the Contract Drawings.
- R. Where the force main discharges into a gravity sewer manhole, the force main entrance to the receiving gravity manhole shall be within 6 inches of the lowest invert of the manhole. Deflector fittings or new inverts shall be installed if necessary to reduce the turbulence of the incoming flow. All manholes with force main discharges shall be epoxy coated or shall utilize an interior construction such as the A-Lok® system to prevent H₂S deterioration of the manhole interior.
- S. New force main connections to existing force mains shall be as shown on the Contract Drawings.

3.09 IDENTIFYING TAPE AND TRACER WIRE

- A. The location of all service laterals and force mains, regardless of material type, installed under these specifications shall be marked by the use of a continuous tape, minimum three inches in width, made of 5 mil polyethylene plastic with a 0.5 mil thick aluminum metallic core or backing. The tape shall be buried in the trench, above the pipe, not more than two feet below the surface. The tape shall be marked indelibly with the words "Sewer Main Below" or similar wording to warn unwary excavators, and shall be green in color.
- B. An insulated minimum 14-gauge tracer wire shall also be installed in the trench immediately along sewer force mains, either attached to or periodically wrapped around the line. The wire shall be branched off to connect to valve boxes and air release valves to allow convenient surface access to the wire for pipe locator connection.

3.10 BYPASS PUMPING

- A. Where flow stoppage may be necessary and the flow is so great as to require pumping, the Contractor shall bypass the sewage around the section or sections of gravity sewer line that are out of service by plugging an existing upstream manhole and pumping sewage to a downstream manhole. The pump and bypass lines shall be of adequate capacity and size to handle the flow. Likewise, bypass pumping may be required at pump stations through pump-around ports, where available. Alternatively, situations may demand that pumping and hauling be performed. The Contractor shall perform whatever bypass operations are necessary to complete the required work and prevent overflow or spillage of raw sewage.
- B. **UNDER NO CIRCUMSTANCES WILL THE DUMPING OF RAW SEWAGE ON PRIVATE PROPERTY, OR INTO STREAMS, STORM SEWER OR CITY STREETS BE ALLOWED.**

- C. Except as may be approved by the Owner's Inspector, temporary connections shall be made at the end of each working day so that overnight pumping is not required. Bypassing of sewage shall be considered a subsidiary obligation of the Contract and no separate payment shall be made for this work unless specifically listed as a pay item on the Bid Form.

3.11 STREAM CROSSINGS

An Aquatic Resource Alteration Permit (ARAP) must be obtained from TDEC where utilities cross USGS-designated blue-line streams or where utility line construction otherwise disturbs these streams. Construction shall comply with the Contract Drawings and with the provisions of the ARAP and SWPPP. Upon completion of construction, the stream and its banks shall be stabilized and/or returned as nearly as possible to their original condition. Cleanup, grading, seeding, planting or restoration of the work area shall be carried out as early as practical as the construction proceeds and in accordance with the ARAP.

PART 4 - TESTING

4.01 GENERAL

- A. Testing and inspection of the completed work shall be accomplished by one or more of the following methods:
 - 1. Visual Inspection
 - 2. Closed Circuit Television (CCTV)/Video Inspection
 - 3. Leak Testing of Gravity Mains
 - a. Low-Pressure Air Testing
 - b. Infiltration Testing
 - c. Exfiltration Testing
 - 4. Deflection Testing of Gravity Mains
 - 5. Vacuum Testing of Manholes
 - 6. Hydrostatic Testing of Force Mains
 - 7. Valve Testing
- B. Upon completion of construction, the Contractor shall remove all sand, dirt, rock and other foreign materials from the sewers and shall conduct his own inspection and testing to locate and repair any defects, and determine when sewers are ready for final inspection and testing by the Owner's Inspector. After all apparent defects have been corrected, the Contractor shall notify the Owner and request a final inspection.
- C. The Owner will not conduct a final inspection until receiving written notice from the Developer's Engineer that the construction is completed in accordance with approved Contract Drawings and Specifications. This notification shall include a report of the results of the inspection and testing performed on the sanitary sewer system components. CCTV/Video files shall be submitted to the Owner at this time.

4.02 VISUAL INSPECTION

- A. Unscheduled visual inspection of the sewer and construction site by the Owner's Inspector shall occur during the course of the construction. The Inspector shall make visual inspection of pipe, fittings, valves and other materials to be incorporated into the work before they are installed. Items found to be defective or otherwise not in accordance with Contract Drawings and Specifications shall be immediately removed from the site.
- B. Visual inspection of grade and alignment, bedding, pipe jointing, manholes, etc. will proceed as work progresses. Acceptance of work at this stage in no way relieves the Contractor of responsibility and does not preclude additional testing at the discretion of the Owner. Any sags, humps, bends or other evidence of misalignment shall be cause for rejection. Improper construction and work not in accordance with the Contract Drawings and Specifications shall also be cause for rejection.
- C. Upon completion of the work, all sewers and manholes shall be inspected for foreign matter such as sand or mud brought in by infiltration or inflow, and any such matter shall be removed before final acceptance. If visual inspection of lines, manholes or other items reveals leaks, structural failures or other defects, the Contractor shall repair such immediately.

4.03 CCTV/VIDEO INSPECTION

- A. The Contractor shall conduct an internal inspection and digital recording of the sewer system using a television instrument. As an alternate to the Contractor performing the television inspection, the Contractor may choose to use the services of the City's crews at a cost determined by the General Manager or his designated representative. The Contractor shall be responsible for correcting all deficiencies discovered by the CCTV inspection at no cost to the Owner.
- B. A remote controlled, adequately lit camera that will travel the length of each section of gravity sewer main from manhole to manhole shall be used to televise all newly installed sewers. The camera shall be of suitable design and manufactured for the express purpose of televising gravity sanitary sewer mains. The camera's path shall be recorded with an onscreen display of footage traveled. Auditory notations by the camera operator regarding locations of service connections, pipe defects, indications of faulty installation and all other important points of interest shall be recorded as permanent record. The view recorded by the camera shall also include an object of reference to assist the viewer in determining the scale of objects within the pipe.
- C. Video quality shall be such that the condition of all interior sections of the main and service laterals on that section of the main are easily discernible. The camera shall allow for articulation that enables a clear view of service laterals in a direction perpendicular to the direction of the main and at a variety of vertical angles to allow viewing of laterals at varying slopes. The image must be clear to the test cap or first bend of the service lateral.
- D. Audio quality shall be adequate to clearly understand remarks of the camera operator.

- E. Video inspection shall commence immediately after line cleaning so that any sag or changes in grade shall be revealed and evidenced by puddling in areas where positive slope is not maintained.
- F. The Contractor shall be responsible for correcting all deficiencies discovered by the CCTV inspection at no cost to the Owner.
- G. At the time of the request for final inspection, the Contractor shall submit to the City Engineer's Office on CD-ROM or DVD media 2 copies of digital files that represent the videotaping of all sewer mains in a project or development. The video record of each section of gravity main between manholes shall be represented by a separate MPEG or AVI format digital file. The disc and its jacket shall be clearly labeled with the name of the subdivision or project and its phase and/or section, as well as the installation date. All references to manholes and mains with regard to videotaping shall be by the same naming convention as that shown on construction plans approved by the City. An index file shall be provided with each disc that explains the meaning of each file name and identifies the CCTV company that produced it.

4.04 LOW-PRESSURE AIR TESTING

- A. Low-pressure air testing is the preferred method of leak testing of gravity sewer mains up through 24 inches in diameter when above groundwater. If the groundwater level is 2 feet or more above the top of the pipe at the upstream end, air testing shall not be used.
- B. Labor, equipment and supplies required for all tests shall be furnished by the Contractor. The test shall be observed by the Owner's Inspector.
- C. Low-pressure air tests shall be made with equipment specifically designed and manufactured for the purpose of testing pipelines using low-pressure air. The equipment shall be provided with an air regulator valve or air safety valve set such that the internal air pressure in the pipeline cannot exceed 8 psig (gauge pressure). Test equipment shall be top quality, in good condition and approved by the Inspector. Plugs shall have a sealing length equal to or greater than the diameter of the pipe being tested and external bracing of the plugs should not be required in order for the plug to hold against internal air pressure. The test equipment shall include accurate, oil-filled pressure gauges to monitor test pressure, safety relief valve(s) and quick-release air bleed valve(s).

- D. The procedure for low-pressure air testing shall be in accordance with ASTM F1417 unless modified herein.
1. Clean the section of sewer line to be tested by flushing or other means prior to conducting the low-pressure air test.
 2. Isolate the section of sewer line to be tested by suitable test plugs and plug all sewer services to be included in the test to prevent air leakage. Such sewer service caps shall be readily removable, and their removal shall provide a socket suitable for making a lateral connection or extension. All plugs and caps shall be securely braced to prevent blow-out against internal pressures. One of the plugs or caps should have an inlet tap, or other provision for connecting a hose to a portable air control source. Allow no one in the manholes while pressurizing the line or during the test.
 3. Immediately following this check or cleaning, test the pipe installation with low-pressure air. Supply the air slowly to the plugged pipe installation until the internal air pressure reaches 4.0 psi more than the average backpressure of any groundwater that may submerge the pipe (an additional 0.43 psi should be added for each foot of groundwater above the pipe). Allow at least 2 minutes for temperature stabilization.
 4. After the stabilization period and with 3.5 psi minimum pressure (above the average backpressure) in the pipeline, air supply shall be disconnected and the time measured which results in a 1 psi pressure drop.
 5. The time required in minutes for the pressure in the section under test to decrease from 3.5 psi to 2.5 psi shall not be less than that shown in the table below.

Low-Pressure Air Test Requirements							
Pipe Dia. (inches)	Min. Time (min:sec)	Length for Min. Time (feet)	Time for Longer Length	Specified Time for Length Shown (min:sec)			
				100 ft	200 ft	300 ft	400 ft
8	7:34	298	1.520*L	7:34	7:34	7:36	10:08
10	9:26	239	2.374*L	9:26	9:26	11:52	15:49
12	11:20	199	3.418*L	11:20	11:24	17:05	22:47
15	14:10	159	5.342*L	14:10	17:48	26:42	35:36
18	17:00	133	7.692*L	17:00	25:38	38:27	51:16
21	19:50	114	10.470*L	19:50	34:54	52:21	69:48
24	22:40	99	13.674*L	22:47	45:34	68:22	91:10

6. It is not necessary to hold the test for the entire period of time indicated in the above table when it is evident that the rate of air loss is zero or less than the allowable, and is authorized by the Inspector.
7. Upon completion of the test, open the bleeder valve and allow all air to escape. Plugs should not be removed until all air pressure in the test section has been reduced to atmospheric pressure.
8. Failure of any section of the pipeline to meet the requirements of this test shall cause the Contractor to determine, at his own expense, the source(s) of leakage. The Contractor shall excavate and repair or replace all defective materials or workmanship, and repeat all testing until results are satisfactory at no additional cost to the Owner.

4.05 INFILTRATION TESTING

- A. Gravity sewers shall be leak tested by an infiltration test if the groundwater is more than 2 feet above the crown of the pipe for the full length of the section to be tested.
- B. Pipe shall be tested for infiltration after the backfill has been placed and the groundwater allowed to return to normal elevation. If an inspection of the completed pipeline or any part thereof shows pipes or joints that allow noticeable infiltration of water, the defective work or material shall be replaced or repaired as directed by the Owner. All visible leaks shall be repaired prior to testing.
- C. The length of line to be tested shall not be less than the length between adjacent manholes and not more than the total length of each size of pipe. The measured infiltration shall not exceed 2.0 gallons per inch of diameter per day per 100 feet of pipe in each section tested.
- D. Rates of infiltration shall be determined by means of V-notch weirs, pipe spigots, or by plugs in the end of the pipe installed in an approved manner and at such times and locations as may be directed by the Engineer.
- E. Failure of any section of the pipeline to meet the requirements of this test shall cause the Contractor to determine, at his own expense, the source(s) of leakage. The Contractor shall excavate and repair or replace all defective materials or workmanship, and repeat all testing until results are satisfactory at no additional cost to the Owner.

4.06 EXFILTRATION TESTING

- A. Where required by the Engineer, leakage testing by exfiltration shall be made by creating a head in the pipeline to be tested by filling the line and either manhole or temporary riser on one end of the line with water. The length of pipe to be tested shall be such that the head over the crown at the upstream end is not less than 2 feet and the head over the downstream crown is not more than 5 feet.
- B. The pipe shall be filled with water in such a manner that the air can be released from the pipe while it is being filled. Before any measurements are made, the pipe shall be kept full of water long enough to allow absorption and the escape of any trapped air to take place. Following this, a test period of at least one hour shall begin. Provisions shall be made for measuring the amount of water required to maintain the water at a constant level during the test period. If the quantity of water required to maintain a constant head in the pipe does not exceed 2.0 gallons per inch of diameter per day per 100 feet of pipe and if all the leakage is not confined to a few joints, workmanship shall be considered satisfactory.
- C. Failure of any section of the pipeline to meet the requirements of this test shall cause the Contractor to determine, at his own expense, the source(s) of leakage. The Contractor shall excavate and repair or replace all defective materials or workmanship, and repeat all testing until results are satisfactory at no additional cost to the Owner.

4.07 DEFLECTION TESTING

- A. Flexible PVC pipe shall pass a go/no-go Mandrel sized to 95% of the actual pipe diameter with the pipe in place and properly backfilled. No testing shall be performed until the pipe has been laid and backfilled for 30 days and any necessary line cleaning is complete.
- B. The Mandrel size shall be based upon the maximum possible inside diameter for the type of pipe being tested, taking into account the manufacturing tolerances of the pipe.
- C. The Mandrel shall have an odd number of legs, or vanes, with a quantity of such equal to or greater than nine. The legs of the Mandrel shall be permanently attached to the Mandrel.
- D. The Mandrel shall be constructed of steel, aluminum, or other material approved by the Engineer or his representative, and shall have sufficient rigidity so the legs of the Mandrel will not deform when pulling through a pipe.
- E. A Mandrel with variable sizes shall not be allowed. The Mandrel dimensions shall be checked by the Engineer or his representative before use by the Contractor.
- F. Failure of any section of the pipeline to meet the requirements of this test shall cause the Contractor to determine, at his own expense, the source(s) of deformity. The Contractor shall excavate and repair or replace all defective materials or workmanship, and repeat all testing until results are satisfactory at no additional cost to the Owner.

4.08 VACUUM TESTING OF SEWER MANHOLES

- A. All new manholes are to be vacuum tested as soon as is practicable after assembly is completed. No standing water shall be allowed in the manhole excavation that may affect the accuracy of the test. Leakage testing on newly rehabilitated manholes shall be accomplished in accordance with ASTM C1244-05A rather than as specified in this Paragraph.
- B. All lifting holes and exterior joints shall be filled and pointed with non-shrink grout for concrete manholes or sealed with compatible sealant for other materials.
- C. All pipes and other entrances into the manhole should be suitably plugged and blocked in such a manner as to prevent displacement of the plugs while the vacuum is being pulled.
- D. Installation and operation of the vacuum equipment and indicating devices shall be in accordance with equipment specifications and instructions provided by the manufacturer. Gauges used for manhole testing shall be oil-filled gauges.
- E. The casting opening shall be sealed with an appropriate testing/sealing device and a vacuum of 10.0 inches of mercury (5 PSIG) pulled on the manhole (DO NOT PUT A POSITIVE PRESSURE ON THE MANHOLE). The time for the vacuum to drop to 9.0 inches of mercury shall be recorded.
- F. Acceptance manholes shall be defined as when the time to drop from 10.0 inches to 9.0 inches of mercury meets or exceeds the following:

Minimum Time (seconds) to Drop From 10.0 Inches to 9.0 Inches of Mercury			
Manhole Diameter	Manhole Depth		
	4 feet to 10 feet	10 feet to 15 feet	15 feet to 25 feet
4 feet	75	90	105
5 feet	90	105	120
6 feet	105	120	135

- G. If the manhole fails the test, necessary repairs shall be made at the Contractor's expense and the vacuum test repeated until the manhole passes the test. A significant number of leaks on a single manhole may be considered as a basis for rejection and replacement at the Contractor's expense.
- H. If the manhole joint mastic or gasket is displaced during the vacuum test, the manhole shall be disassembled and the seal replaced.

4.09 HYDROSTATIC TESTING OF SEWER FORCE MAINS

- A. All newly laid pipe or any valved section thereof shall be subjected to hydrostatic pressure testing. Conduct hydrostatic testing in accordance with AWWA C600 for ductile iron pipe or AWWA C605 for PVC pipe.
- B. Where practicable, pipelines shall be tested in lengths between line valves or plugs of no more than 3,000 feet.
- C. Hydrostatic testing shall be conducted only with potable water. Due to the inherent safety hazard potential associated with testing components and systems with compressed air or other compressed gases, pressure testing shall never be accomplished using compressed air.
- D. The Contractor shall furnish all gauges, recording devices, meters, pumps, pipe, connections and other equipment required to conduct the test and shall maintain said equipment in condition for accurate testing as determined by the Owner. Gauges used for pressure tests shall be oil-filled gauges.
- E. Hydrostatic test results shall be recorded on an appropriate chart recorder. The Contractor shall furnish a recording gauge and water meter for recording pressure charts and for measuring makeup water used during the hydrostatic testing. Recording pressure charts shall be submitted to the Owner at the conclusion of testing. The pressure recording device shall be suitable for outside service, with a range from 0–200 psig, 24-hour spring wound clock, designed for 9-inch charts, and shall be approved by the Owner. Such pressure recording devices may be available from Foxboro Company, Foxboro, Massachusetts; Bristol Division of ACCO, Waterbury, Connecticut; or Weksler Instruments Corporation, Freeport, New York.
- F. Prior to testing, the Contractor shall place sufficient backfill to prevent pipe movement. When local conditions require that the trenches be backfilled immediately after the pipe has been laid, the testing may be carried out after backfilling has been completed but before placement of permanent surfacing. The Contractor shall ensure that thrust blocking or other types of restraining systems will provide adequate restraint prior to pressurizing the pipeline.

- G. Cross Connection Control: When existing water mains are used to supply test water, they should be protected from backflow contamination by temporarily installing a double check valve assembly between the test and supply main or by other means approved by the Owner. Prior to pressure and leakage testing, the temporary backflow protection should be removed and the main under test isolated from the supply main.
- H. Test Pressure Requirements:
1. The test pressure shall not be less than 1.25 times the stated working pressure of the pipeline measured at the highest elevation along the test section and not less than 1.5 times the stated working pressure at the lowest elevation of the test section.
 2. The test pressure shall not exceed the thrust restraint design pressure or 1.5 times the pressure rating of the pipe or joint, whichever is less (as specified by the manufacturer).
 3. The test pressure shall not exceed the rated working pressure of the valves when the pressure boundary of the test section includes closed, resilient seated gate valves or butterfly valves.
 4. Valves shall not be operated in either direction at a differential pressure exceeding the rated valve working pressure. A test pressure greater than the rated valve working pressure can result in trapped test pressure between the gates of a double-disc gate valve. For tests exceeding the rated valve working pressure, the test setup should include a provision, independent of the valve, to reduce the line pressure to the rated valve working pressure on completion of the test. The valve can then be opened enough to equalize the trapped pressure with the line pressure, or the valve can be fully opened if desired.
- I. Test Procedure:
1. Each valved section of pipeline shall be slowly filled with potable water using a metered backflow-protected assembly provided by the Owner. When venting air from pipelines, it is important to limit the pipeline fill rate to avoid excessive surge pressures when the water reaches the air venting opening(s).
 2. Before applying the specified test pressure, air shall be expelled completely from the pipeline section under test. If permanent air vents are not located at all high points, corporation cocks shall be installed at such points to expel air as the line is filled with water. After all the air has been expelled, close the corporation cocks and apply the test pressure. At the conclusion of the pressure test, remove the corporation cocks and plug or leave in place at the discretion of the Owner.
 3. The specified test pressure shall be applied using a suitable pump connected to the pipeline in a manner satisfactory to the Owner. The specified test pressure shall be based on the elevation of the lowest point of the pipeline or section under test and corrected to the elevation of the test gauge, in accordance with test pressure requirements specified herein.
 4. The pipeline shall be allowed to stabilize at the test pressure before conducting the hydrostatic test. This may require several cycles of pressurizing and bleeding trapped air prior to beginning the test. It is recommended that the line remain pressurized for a minimum of 24 hours before testing in order for joints to tighten and pockets of air to dissolve in the water.
 5. The hydrostatic test shall be at least 2 hours in duration after reaching the specified test pressure where joints are exposed and at least 8 hours where joints are covered.

6. The test pressure shall not vary by more than +/- 5 psi for the duration of the test. Test pressure shall be maintained within this tolerance by adding makeup water through the pressure test pump into the pipeline. The amount of makeup water added shall be accurately measured (in gallons per hour) by suitable methods and shall not exceed the applicable testing allowance as specified herein.

J. Visual Inspection: Any exposed pipe, fittings, valves, hydrants and joints shall be examined carefully during the hydrostatic pressure test. Any damaged or defective materials that are discovered during or following the pressure test shall be repaired or replaced at the Contractor's expense, and the test shall be repeated until satisfactory results are obtained.

K. Testing Allowance:

1. Testing allowance shall be defined as the maximum quantity of makeup water that is added into a pipeline undergoing hydrostatic pressure testing, or any valved section thereof, in order to maintain pressure within +/- 5 psi of the specified test pressure (after the pipeline has been filled with water and the air has been expelled).
2. No pipe installation will be accepted if the quantity of makeup water is greater than that determined by the following formula:

$$L = \frac{S \cdot D \cdot (P)^{1/2}}{148,000}$$

Where:

L = testing allowance (makeup water), in gallons per hour

S = length of pipe tested, in feet

D = nominal diameter of the pipe, in inches

P = average test pressure during the hydrostatic test, in pounds per square inch (gauge pressure)

3. This formula is based on a testing allowance of 10.5 gpd/mile/inch of nominal diameter at a pressure of 150 psi. Values of testing allowance at various pressures are shown in the following table. When testing against closed metal-seated valves, an additional testing allowance per closed valve of 0.0078 gal/hr/inch of nominal valve size shall be allowed.

Hydrostatic Testing Allowance per 1,000 feet of pipeline (gallons per hour)*											
Average Test Pressure (psi)	Nominal Pipe Diameter (inches)										
	4	6	8	10	12	14	16	18	20	24	30
250	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92	2.14	2.56	3.21
225	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82	2.03	2.43	3.04
200	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29	2.87
175	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15	2.68
150	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99	2.48
125	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81	2.27
100	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62	2.03
75	0.23	0.35	0.47	0.59	0.70	0.82	0.94	1.05	1.17	1.40	1.76
50	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.96	1.15	1.43

* If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

- L. Acceptance of the installation shall be determined on the basis of testing allowance. Should any test of pipe laid disclose leakage greater than that specified, the Contractor shall, at his own expense, locate and repair the defective joints until the leakage is within the specified allowance. All visible leaks are to be repaired regardless of the allowance used for testing. Hydrostatic test results shall be recorded on an appropriate chart recorder as specified herein. A copy of the test chart shall be provided to the Owner.

4.10 VALVE TESTING

Upon completion of the work, the Contractor shall operate all buried valves in the presence of the Owner's Inspector to verify proper operation of each valve.

END OF SECTION

SECTION 02725

BORING AND JACKING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. All water and sewer mains installed in a bore under streets, highways and railroads must be cased as specified herein.
- B. Copper water services 2" in diameter or smaller and schedule 40 PVC or ductile iron sewer services may be installed without casing. The bore for any such uncased service shall not be greater than 2 inches larger than the maximum OD of the carrier pipe. Services encroaching TDOT right-of-way may be required to be cased at the discretion of TDOT.

1.02 RELATED WORK

- A. Section 02713: Water Distribution Systems
- B. Section 02722: Sanitary Sewer Systems

1.03 REGULATIONS AND PERMITS

- A. Permits for crossing highways or railroads will be obtained by the Owner. The Developer's Engineer shall provide the Owner with any and all documents required by the Owner to obtain the necessary permit(s), including a profile of the road or railroad bore and completed TDOT Pipeline Encroachment Form. The Contractor shall verify that such permits have been obtained before construction commences.
- B. For highway crossings, the Contractor shall satisfy TDOT to the extent of the Owner's posted Surety Bonds.
- C. For railroad crossings, the Contractor shall furnish Certificates of Insurance in amounts established by the railroad company, naming the railroad as the insured, and complete required application forms to be used by the City to obtain the permit as specified by the railroad.
- D. Notify all related agencies prior to commencing construction activities.

PART 2 - PRODUCTS

2.01 STEEL CASING PIPE

- A. Encasement pipe shall be smooth wall welded steel with minimum yield strength of 35,000 psi. A protective bituminous coating shall be applied to the outside of the pipe.

- B. Steel casing pipe shall be of sufficient strength to meet the loading conditions of H-20 loading for highway crossings and Cooper E-80 loading for railroad crossings, and shall have the minimum pipe diameter and wall thickness shown in the following table. Where mechanical joint pipe requires a larger diameter casing pipe than push-on joint pipe, a separate line item for MJ pipe has been provided in the following table. Where bell restraint harnesses have been specified for the carrier pipe, an appropriately sized casing pipe shall be specified to accommodate the restraints and required casing spacers.

Carrier Pipe Nominal Diameter (inches)	Minimum Steel Casing Pipe Diameter (inches)	Minimum Wall Thickness (inches)	
		Highway Crossing	Railroad Crossing
4	12	0.188	0.188
6	14	0.250	0.250
8	16	0.250	0.250
8 MJ	18	0.250	0.250
10	18	0.250	0.250
10 MJ	20	0.250	0.281
12	20	0.250	0.281
12 MJ	24	0.250	0.312
14 - 16	24	0.250	0.312
16 MJ	30	0.312	0.406
18 - 21	30	0.312	0.406
24 - 27	36	0.375	0.469
30	42	0.500	0.562
36	48	0.500	0.594
36 MJ	54	0.500	0.719

2.02 CARRIER PIPE

Carrier pipe installed in the casing pipe shall be as indicated on the Contract Drawings.

2.03 CASING SPACERS

- A. Casing spacers shall be provided so that the carrier pipe is in a centered/restrained position. The casing spacers shall be constructed of circular stainless steel bands that bolt together to form a shell around the carrier pipe and shall be lined with PVC or EPDM to protect the carrier pipe and prevent slippage. The spacer shall be designed with risers and runners to support the carrier pipe within the casing.
- B. The shell shall be minimum 14-gauge T-304 stainless steel and shall be manufactured in minimum widths of 8 inches and 12 inches. The riser shall be constructed of minimum 10-gauge T-304 stainless steel and shall be sized to support all loads and shall support the carrier pipe within the casing in the centered/restrained position. The runners shall be a minimum width of 2 inches and be constructed of glass-reinforced polymer with beveled ends.

- C. The spacers shall at a minimum be positioned at 1 to 2 feet on either side of the joint and at the midpoint. Additional spacers may be required where recommended by the manufacturer and/or Engineer.
- D. Casing spacers shall be Models CSS8 and CSS12 by CCI Pipeline Systems or S8G-2 and S12G-2 by Pipeline Seal and Insulator, Inc.

2.04 END SEALS

A wrap-around self-curing rubber end seal shall be applied to each end of the casing pipe. End seals shall be Model ESW by CCI Pipeline Systems or Model "W" by PSI, Inc.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform all crossings according to the requirements of the governing highway department or railroad company.
- B. Notify the appropriate authorities involved and request their supervisory services during construction.
- C. Provide necessary safeguards to protect the crossing.
- D. Where bored highway installations are not shown on the Contract Drawings, open cut the crossing and provide a casing pipe only if required by the governing highway department or Engineer.
- E. All uncased roadway punches shall be approved by the City Engineer prior to construction.
- F. Excavation shall be unclassified and no distinction shall be made between rock and other materials excavated.
- G. No extra payment will be provided for tunneling through rock. The contractor shall provide whatever means necessary to complete road bores even if rock is encountered. All line items referencing road bores shall include boring or tunneling as required. No change orders shall be issued if rock is encountered during road boring.

3.02 INSTALLATION

- A. Perform all crossings in the manner shown on the drawings, except as otherwise directed by the governing highway department or railroad company.
- B. Dry bore an opening under the crossing.
- C. Jack the casing pipe, of the type and size specified, into the bored opening.

- D. Install the appropriate carrier pipe into the casing pipe.
- E. Test the carrier pipe according to the appropriate Utility Sections (02713 or 02722).
- F. Alignment and grade shall be installed and maintained per the Contract Drawings.
- G. Bores which are not on horizontal or vertical alignment shall be rebored. Abandoned bore holes shall be filled with flowable fill.
- H. Install carrier pipe with casing spacers to maintain alignment inside casing pipe. Casing spacers shall be installed 1 foot from each end of the pipe joint and at the midpoint.
- I. Install casing end seals and casing vents upon completion of installation of carrier pipe.

END OF SECTION

TUNNELING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. This item shall include the furnishing and installation of a tunnel with steel liner plates and carrier pipe.
- B. The Contractor shall conform to all requirements of the Tennessee Department of Transportation or other governing highway department.

PART 2 - PRODUCTS

2.01 TUNNEL LINER PLATE

- A. The tunnel liner shall be constructed of 12 gauge, bituminous coated, galvanized, or Type 2, aluminized two or four flanged steel plates bolted together to the diameter specified on the Contract Drawings, unless the Owner approves the use of an alternate material. The space between the liner and the edge of excavation shall be filled with grout placed under pressure.
- B. The steel lining shall consist of plates that have a minimum tensile strength of 42,000 psi, minimum yield of 28,000 psi, elongation at 2 inches of 30% and do not exceed 18 inches in width. Each circumferential ring shall be composed of the number and length of plates to complete the required diameter. The Contractor shall submit details of the lining for approval.
- C. All plates shall be punched for bolting on both longitudinal and circumferential seams and shall be so fabricated as to permit complete erection from the inside of the tunnel. The longitudinal seam shall be of the lap type with offset equal to gauge of metal for full width of plates including flanges, and shall have staggered bolt construction, so fabricated as to allow the cross-section of the plate to be continuous through the seam. All plates shall be of uniform fabrication and those intended for one size tunnel shall be interchangeable.
- D. The material used for the construction of these plates shall be new and unused and suitable for the purpose intended. Plates shall be fabricated with material in accordance with ASTM A819 and AASHTO M274.
- E. After the plates are formed to shape and after all holes are punched, the plates shall be galvanized on all surfaces by the hot-dip process. A coating of prime western spelter, or equal, shall be applied at the rate of not less than 2 ounces per square foot of double exposed surface. If the average spelter coating as determined from the required samples is less than the amount specified above, or if any one specimen shows a deficiency of 0.2 ounce, the lot

shall be rejected. Spelter coating shall be of first-class commercial quality free from injurious defects such as blisters, flux and uncoated spots.

- F. All nuts and bolts shall be galvanized and shall be fabricated in accordance with ASTM A307, Grade A.
- G. Plates shall be fabricated with grout holes to facilitate grouting above and around the tunnel liner. These grout openings shall be 2-inch I.P.T. half couplings welded into a hold in the center corrugation of a plate and a galvanized C.I. plug shall be provided for each opening to permit tight closure after grout is pumped. All rings are to be provided with grout holes so that the spacing of holes will be on a maximum spacing of 18-inch centers at the top of the tunnel and at the top quarter points, staggered with the holes at the top.

2.02 GROUT

The grout shall consist of Portland cement, water, sand and 2% approved additive (Bentonite, Septamine Seaex, Hydrocide liquid, etc.). One part Portland cement with additive shall be combined to four parts clean sand and sufficient water added to provide a grout having the consistency of thick cream when well mixed.

2.03 CARRIER PIPE

The carrier pipe shall be as specified in the Contract Drawings.

PART 3 - EXECUTION

3.01 EXCAVATION

- A. Excavation shall be unclassified and no distinction shall be made between rock and other materials excavated. Blasting is acceptable only with explicit written approval from the authority having jurisdiction over tunneled area.
- B. Construction of the tunnel shall be carried out in such a manner that settlement of the ground surface above the tunnel shall be held to an absolute minimum. Where ground conditions are unstable, poling plates or poling boards shall be used to prevent caving of material above the tunnel before the liner plates can be installed. Steel liner plates shall be installed as soon as possible after the excavation is removed and excavation shall not be removed more than 24 inches ahead of the installed liner plates. Excavation shall be carried on in such a manner that voids behind the liner plates will be held to a minimum. However, should any boulders larger than 12 inches in diameter be encountered, they shall be removed so that none are closer than 6 inches to the outer face of the liner plate. Where boulders are excavated below the invert of tunnel liner plates, the holes shall be backfilled with crushed stone (#57 or 67).

3.02 LINER PLATE

- A. When installing liner plate by the tunneling method, the excavation shall be performed in such a manner that voids between the undisturbed earth and the liner plate shall be maintained at a minimum. Any void occurring shall be filled with a Portland cement and sand grout pumped under pressure through grouting openings in the liner plate.
- B. The minimum provision for grouting openings shall be one opening in a top plate of the tunnel at locations not to exceed 54 inches apart. Additional plates with grouting openings are to be installed at the top quarter points on each side between the top openings. The opening shall be staggered, but shall not exceed 54 inches in any one line. Grout vent pipes will be required at a minimum of one per monolithic pour.

3.03 GROUTING

- A. A pump capable of exerting sufficient pressure to assure the filling of all voids between the liner plate and the undisturbed ground shall be provided for placing the grout. Minimum acceptance pressure to fill voids will be five pounds per square inch.
- B. Pumping of grout shall be done (1) at the completion of the installation of approximately each 9 feet of liner plate, (2) at more frequent intervals than 9 feet if conditions indicate the necessity, and (3) at the end of a work shift or for stopping work for any reason.

3.04 CARRIER PIPE

- A. Contractor shall jack the pipe by means of air bladders, blocks, or other suitable method. Once carrier pipe is established, Contractor shall pour a lean concrete bedding for the carrier pipe.
- B. The carrier pipe shall be adequately strapped to the tunnel flanges behind each bell with 2" x ¼" stainless steel straps bolted to the liner plate flanges with ½" stainless steel bolts and nuts. Concrete bulkheads will be placed at each end of the tunnel; thickness and placement of which shall be subject to the Engineer's approval.

3.05 BACKFILL

Backfill of the tunnel shall consist of sand, #57 crushed stone, or pea gravel and shall be blown into the tunnel to fill the void between the inside wall of the tunnel and the outside edge of the carrier pipe to the top of the carrier pipe.

END OF SECTION

HORIZONTAL DIRECTIONAL DRILLING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish all materials and equipment necessary for the horizontal directional drilling of utility lines as called for on the Contract Drawings.
- B. Provide all labor, equipment and materials to perform the directional bore.
- C. Comply with all permits and conditions related to the work for this location.

1.02 RELATED WORK

- A. Section 02713: Water Distribution Systems
- B. Section 02722: Sanitary Sewer Systems

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE

Where indicated on the Contract Drawings, restrained joint ductile iron pipe equivalent to American Flex Ring or U.S. Pipe T.R. Flex with minimum pressure class 350 shall be used for directional bores.

2.02 HIGH DENSITY POLYETHYLENE PIPE (HDPE)

- A. HDPE pipe shall only be used for directional bores as approved by the City Engineer.
- B. Pipe shall have a DR number 9 with a working pressure of 200 psi and be sized to provide inside diameter equal to or greater than the size shown on the Contract Drawings.
- C. Materials: Polyethylene pipe and fittings shall be made from resin meeting the requirements of the Plastic Pipe Institute as PE 3408. The resin shall meet the requirements of ASTM D3350-02 with a cell classification of 345464C. The requirements of this cell classification are:

HDPE Resin Specifications

Property	Specification	Unit	Typical Value
Material Designation	PPI/ASTM		PE 3408
Material Approval	NSF #14		
Material Classification	ASTM D1248		III C5 P34
Cell Classification	ASTM D3350-02		345464C
Density	ASTM D1505	g/cm3	0.955
Melt Index	ASTM 1238	gm/10 min	0.11
Flexural Modulus	ASTM D790	psi	135,000
Tensile Strength	ASTM D638	psi	3,200
Slow Crack Growth			
ESCR	ASTM D1693	hours in 100% igepal	>5,000
PENT	ASTM F1473	hours	>100
HDB @73 deg F	ASTM D1693	psi	1,600
UV Stabilizer	ASTM D1603	%C	2.5%

- D. Butt Fusion Fittings: HDPE fittings shall be PE 3408, HDPE, Cell Classification of 346464C as determined by ASTM D3350-02, and approved for potable water use by the AWWA. Butt fusion fittings shall have a manufacturing standard of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans. Fabricated fittings are to be manufactured using data loggers. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the Quality Control records. All fittings shall be suitable for use as pressure conduit, and per AWWA C906, have a nominal burst value of 3.5 times the working pressure rating of the fitting.

- E. Pipe Manufacturer’s Quality Control: The pipe manufacturer shall have an ongoing Quality Control program for incoming and outgoing materials. HDPE resins for manufacturing of pipe shall be checked for density, melt flow rate, and contamination. The manufacturer of the HDPE resin shall certify the Cell Classification as indicated in Paragraph C above. These incoming resins shall be approved by plant Quality Control and verified as approved by NSF before being converted to pipe. Pipe shall be checked for outside diameter, wall thickness, length, roundness and surface finish on the inside, outside and end cut.

- F. HDPE pipe shall be joined together at the transition points to other mechanical joint adapters. Mechanical joint adapters shall have a manufacturing standard of ASTM D3261. They shall have a pressure rating equal to the pipe.

- G. A minimum of 100 feet of restrained joint ductile iron pipe shall be provided on the pipe preceding and the pipe following the HDPE. Appropriate restraint methods include using restrained joints equivalent to American Flex Ring or U.S. Pipe T.R. Flex.

PART 3 - EXECUTION

3.01 SCOPE OF WORK

- A. Fabricate, directionally drill and install pipe as called for on the Contract Drawings.
- B. Hydrostatically pressure test the pipe in accordance with the requirements of Sections 02713 or 02722, as appropriate.
- C. Provide complete copies of as-built drawings for the pipeline crossing. As-built drawings shall include plan view and profile view.
- D. Clean up all affected sites, and restore all areas to pre-construction condition.

3.02 SUBMITTALS

The Contractor shall prepare a schedule for the work and submit to the Engineer for approval. The schedule shall include all major tasks to be performed including the following:

- A. Pipe delivery.
- B. Rig mobilization and setup.
- C. Pipe assembly.
- D. Pilot hole drilling.
- E. Pre-reaming.
- F. Pre-testing and pigging before installation.
- G. Pipe pulling.
- H. Pre-testing and pigging pipe after reinstallation.
- I. Restoration and demobilization.

3.03 EQUIPMENT AND MATERIALS TO BE FURNISHED BY THE CONTRACTOR

The Contractor shall furnish all equipment and material required to complete the Scope of Work that shall include but not be limited to the following:

- A. Drilling equipment.
- B. Water pumps, hoses, fittings, storage tanks, filters, and erosion prevention and sediment control measures as required.
- C. Drilling fluids containment, collection, cleaning and disposal equipment, and materials.

- D. Fuel and lubricants.
- E. Bentonite and related mixing equipment.
- F. Carrier pipe
- G. All welding equipment for HDPE as required.
- H. All hydrostatic and pneumatic testing equipment and materials.
- I. Sidebooms, cranes, backhoes, trucks, and other equipment and materials necessary to load and unload and to support and smoothly transition the pipe while being pulled into the reamed hole.
- J. All equipment and materials necessary to restore project areas to pre-existing condition or better.

3.04 INSTALLATION

- A. General: The Contractor shall install appropriate sections of the pipeline indicated on the Contract Drawings by the horizontally drilled, directionally controlled method of construction. This method shall consist of the drilling of a pilot hole within the designated tolerances for radius requirements, followed by enlargement of the hole to accommodate the carrier pipe.
- B. Instrumentation: The Contractor shall at all times provide and maintain instrumentation that will accurately locate the pilot hole in the X, Y and Z axis relative to the ground surface. Drill fluid flow rate and pressure must also be monitored.
- C. Tolerances:
 - 1. A smoothly drilled pilot hole shall follow the design centerline of the pipe profile and alignment indicated on the Contract Drawings. At no point in the bore will the combined radii in the plan and profile exceed the allowable minimum radius recommended by the pipe manufacturer.
 - 2. The course of the pilot hole must stay within the given right-of-way at all points along the drilled route. Contractor shall provide and use a separate steering system employing a ground survey grid system, such as "Tru-Tracker".
 - 3. The Contractor shall have accurate working gauges that register tensile force being used to pull the pipeline back through the reamed borehole. It is the Contractor's responsibility to prepare the reamed out hole such that pullback operations do not exceed the tensile strength of the pipe. The Contractor shall provide estimated calculations for the pulling loads and allowable loads before pull back operations begin. If during the pipeline pulling process this force reaches 75 percent of the allowable load for the pipeline, the project inspector shall be notified immediately. Logs must be kept intact referencing all forces exerted on the pipeline during pullback.
 - 4. The Contractor shall provide adequate supports along the stringing area to protect the pipe and allow free movement of the pipeline during pullback.
 - 5. During pullback operations, Contractor shall monitor roller operation and use sidebooms if required to assist movement of the pipe. Situations, which could cause

damage to the pipe material, shall be corrected immediately. Damaged pipe shall be replaced by the Contractor before pulling operations resume.

3.05 DRILLING AND MUD CUTTINGS

- A. The horizontal directional drilling operation is to be operated in a manner to eliminate discharge of water, drilling mud and cuttings into the creek or land areas involved during the construction process. Contractor shall immediately contain and clean up any inadvertent returns, spills or releases. Contractor shall also provide equipment and procedures to maximize the re-circulation and reuse of drilling mud to minimize waste disposal.
- B. Disposal of drilling fluids shall be the responsibility of the Contractor and shall be conducted in strict compliance with all applicable environmental regulations and permit requirements. All costs related to disposal shall be borne by the Contractor.
- C. Water supply is the Contractor's responsibility, whether purchased locally, hauled in, or pumped from the creek. If pumped from the creek, the Contractor must comply with the rules and regulations of the Tennessee Department of Environment and Conservation.
- D. Drilling fluids must be free of all additives that will adversely affect the environment.

3.06 REAM AND PULLBACK

- A. Pre-reaming: Pre-reaming operations shall be conducted at the discretion of the horizontal drilling Contractor. All provisions of this specification relating to simultaneous reaming and pulling back operations shall also pertain to pre-reaming operations.
- B. Pulling Loads: Contractor shall be responsible for determining safe pulling loads required for proper installation. Such loads shall be minimized as required to prevent failure of the pipeline during installation.
- C. Torsional Stress: A properly sized and fully operational swivel will be installed between the reaming assembly at the end of the drill pipe and the pipeline to restrict torsional stress from being transmitted to the pipeline.
- D. Pull Section Support: The pull section shall be supported as it proceeds during pull back so that it moves freely and the pipe material is not damaged.

3.07 INSTALLING HDPE PIPE

- A. HDPE pipe shall be assembled utilizing field-site butt fusion joints. Personnel performing butt fusion joining shall be certified by pipe manufacturer.
- B. Each piece of pipe must be held by a clamping device so it will not move and pipe ends shall be faced to establish clean mating surfaces. Pipe profiles must be rounded and aligned with each other to prevent mismatch of pipe walls.

- C. Heat the ends of the pipe to the pipe manufacturer's recommended temperature, interface pressure, and time duration. Keep heater faces clean to prevent molten plastic from sticking to the heater faces.
- D. After heating, remove heater tool and bring molten pipe ends together with sufficient pressure to form a homogenous joint. Hold the molten joint immobile under pressure until cooling has occurred and joint achieves strength.
- E. After installation, the pipe shall be tested in accordance with the requirements of Section 02713 or 02722, as appropriate.

3.08 CLEANUP, REPAIRS AND RESTORATION

- A. The Contractor is responsible for leaving all areas affected by his construction activities in a condition equal to or better than the condition before construction.
- B. The Contractor shall fully restore all area around entry and exit pits as soon as work is completed. Fill to previous existing ground elevation and grade any areas where settlement occurs due to subsidence.

END OF SECTION

SECTION 02821

CHAIN-LINK FENCES AND GATES

PART 1 – GENERAL

1.01 WORK INCLUDED

Construct chain link fences, gates and appurtenances in accordance with the Contract Drawings and these specifications.

1.02 SUBMITTALS

- A. Product Data: For each product indicated
- B. Shop Drawings: Show locations, components, materials, dimensions, sizes, weights, finishes of components, installation and operational clearances, gate swings, and details of post anchorage and attachment and bracing.

1.03 RELATED WORK

Section 03300: Cast-In-Place Concrete

PART 2 – PRODUCTS

2.01 CHAIN-LINK FENCE FABRIC

- A. Steel Chain-Link Fence Fabric: Comply with Chain Link Fence Manufacturers Institute’s “Product Manual” and AASHTO M181.
- B. Mesh and Wire Size: 2-inch (50-mm) mesh, 0.120-inch (3.05-mm) diameter. Vinyl coated, Type 1, Class D, color as specified by Owner.
- C. Fabric Selvage: Twisted at top selvage and knuckled at bottom.

2.02 LINE POSTS

- A. The line posts shall be one of the following types, and of the lengths shown on the Contract Drawings. They shall be 1.5 inch (1.900 O.D.) galvanized steel pipe meeting the requirements of ASTM A53, or (1.875 inch by 1.625 inch) galvanized rolled form steel Standard C-Section meeting the requirements of ASTM A570 Grade E, or (1.875 inch by 1.625 inch) galvanized H-Section or O.D. (1.5 inch (1.900 O.D.)) aluminum-alloy standard (ANSI Schedule 40) pipe meeting the requirements of ASTM B241, Alloy 6063, Temper T6, or 1.5 inch (1.900 O.D.) triple coated steel pipe with a (0.120 inch) minimum wall thickness.

- B. The pipe shall be manufactured by cold rolling and electric resistance welding of steel strip conforming to ASTM A569, ASTM A607 or ASTM A446, Grade D. All tubing shall be given corrosion protection by in-line application of hot-dip galvanizing, followed by a chromate conversion coating and an electrostatically applied clear acrylic or polyester coating on the outside surface. The inside surface shall be given corrosion protection by hot-dip galvanizing or by in-line application of a zinc rich paint after fabrication.
- C. External Protective Coatings:
 - 1. Hot-Dipped Zinc Coating per ASTM B6 high grade and special high grade. The weight of the hot-dipped zinc coating shall be a minimum of 245 grams per square meter (0.8 oz/s.f.). The weight of zinc coating shall be determined in accordance with ASTM A90.
 - 2. The electrostatically applied clear acrylic or polyester coating thickness shall be at least 2.5 μm (0.1 mils).
- D. Internal Protective Coatings: The interior surface shall be hot-dipped galvanized with a minimum of 25 grams (0.9 ounce) of zinc, or painted after welding with a 7.5 μm (0.3 mil) thickness of zinc rich paint. The coating shall be not less than 80% zinc powder by weight and capable of providing galvanic protection.

2.03 END POSTS, CORNER POSTS, GATE POSTS AND BRACES

- A. The end and corner posts shall be 2.5 inch galvanized standard steel pipe meeting the requirements of ASTM A53, or 2.5 inch, aluminum alloy standard (ANSI Schedule 40) pipe, meeting the requirements of ASTM B241, Alloy 6063, Temper T6, or 2.5 inch triple coated steel pipe with a (0.130 inch) minimum wall thickness and meeting the specified requirements as set forth under Paragraph 2.02. End and corner post length shall be 9'-6".
- B. End and corner post braces shall be 1.25 inch (1.660 O.D.) galvanized standard steel pipe meeting the requirements of ASTM A53, or 1.25 inch (1.660 O.D.) aluminum-alloy standard (ANSI Schedule 40) pipe, meeting the requirements of ASTM B241, Alloy 6063, Temper T6, or 1.25 inch (1.660 O.D.) triple coated steel pipe with a 2.8mm (0.111 inch) minimum wall thickness and meeting the specified requirements as set forth in Paragraph 2.02.
- C. Gate Posts shall be 3.0 inch galvanized standard steel pipe meeting the requirements of ASTM A53, or 3-inch aluminum-alloy standard (ANSI Schedule 40) pipe meeting the requirements of ASTM B241, Alloy 6063, Temper T6. Gate post length shall be 10'-0".

2.04 BARBED WIRE

- A. The barbed wire shall consist of three (3) No. 12-1/2 gauge twisted steel line wires with No. 14 gauge four-point barbs spaced not more than 125 mm (5 inches) apart. It may be either galvanized or aluminum coated. The galvanized wire shall meet the requirements of ASTM A121, chain link fence grade.

- B. At the option of the Contractor, high tensile strength barbed wire may be used. If the Contractor elects to furnish high tensile strength barbed wire, it shall meet the requirements of ASTM A121 with the following exceptions:
1. The coated line wires shall have a nominal diameter of 1.70mm (0.067 inch). The coated barbed wires shall have a nominal diameter of 1.45mm (0.057 inch).
 2. The minimum weight of zinc coating shall be 230 grams per square meter (0.75 ounce/s.f.) for the line wire and 215 grams per square meter (0.70 ounce/s.f.) for the barbed wire.
 3. The line wire shall have a minimum tensile strength of 2.10 kN (475 pounds) per individual strand.
- C. Aluminum alloy barbed wire shall consist of three (3) twisted strands of 2.8mm (0.110 inch) line wire with 2mm (0.080 inch) diameter four-point barbs spaced not more than 125mm (five inches) apart. The wire and barbs shall meet the requirements of ASTM B211 alloys of 5052-0 for the wire and 5052-H38 for the barbs.

2.05 MISCELLANEOUS FITTINGS AND HARDWARE

- A. Zinc-coated miscellaneous fittings and hardware shall be commercial grade steel or better quality, pressed, wrought or cast as appropriate to the article, and sufficient in strength and other properties to provide a balanced design when used in conjunction with fabric, posts and wires of the quality specified herein. All steel fittings and hardware shall be galvanized in accordance with AASHTO M111.
- B. Aluminum alloy miscellaneous fittings and hardware shall be wrought or cast aluminum to the requirements of AASHTO M181, Table I.

2.06 WIRE TIES

Wire ties shall be No. 9 gauge and shall be zinc-coated steel, aluminum-coated steel, or aluminum alloy, sufficient in strength and other properties to provide a balanced design when used in conjunction with fabric, posts and wire of the qualities specified herein.

2.07 TENSION WIRE

Tension wire shall meet the requirements of AASHTO M181.

2.08 TRUSS RODS AND TURNBUCKLE

Truss rods shall be 9.5mm (3/8 inch) diameter, shall be equipped with a turnbuckle having a take-up of not less than 100mm (four inches) and shall be galvanized in accordance with AASHTO M111.

2.09 POST TOPS AND EXTENSION ARMS

- A. Posts shall be fitted with ornamental tops or extension arms as shown on the Contract Drawings. The post tops shall fit over the outside of posts and shall exclude moisture from posts.

- B. Extension arms shall be vertical or extend out from the fence line at approximately 45 degrees as shown on the Contract Drawings. The extension arms shall be suitably notched or slotted to support and space the barbed wire.
- C. Fabrication of all materials shall be within reasonable close conformity to the sizes, shapes and dimensions and other factors set out in these specifications or shown on the Contract Drawings, and shall display careful, finished workmanship.
- D. The weights specified for steel posts, braces and rails are nominal weights, and a tolerance of +/- 5% will be permitted.

2.10 GATES

- A. Fence gates shall be of the types and sizes shown on the Contract Drawings. They shall be swing-type, complete with latches, stops, keepers, hinges, and fabric. The latch shall have a provision for fastening with a padlock. The gates shall be covered with fabric matching the fence. The hinges shall be of adequate strength to support the gate and shall not twist or turn under action of the gate. The gates, gate posts and braces shall be of the same kind and finish as the adjoining fence. All gate posts and rails shall be furnished with ball caps and rail ends.
- B. Posts, braces and framing members for chain-link fence gates shall be standard weight pipe meeting the requirements of Paragraph 2.03.
- C. Fabric for chain-link fence gates shall meet the requirements of Paragraph 2.01.
- D. Barbed wire for chain-link fence gates shall meet the requirements of Paragraph 2.04.
- E. Miscellaneous fittings and accessories for chain-link fence gates shall meet the applicable requirements of Paragraphs 2.05, 2.06, 2.07, 2.08, and 2.09. The hinges shall be of such design to allow the gate to swing back 180 degrees, parallel with the fence line.

2.11 CAST-IN-PLACE CONCRETE

- A. General: Comply with ACI 301 for cast-in-place concrete. Use materials consisting of Portland cement complying with ASTM C150, aggregates complying with ASTM C33, and potable water.
- B. Concrete Mixes: Class A as set forth in Section 03300.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. General: Install chain-link fencing to comply with ASTM F567 and more stringent requirements if indicated on the Contract Drawings or required by the Engineer. Do not begin installation before final grading is completed, unless otherwise permitted by Engineer. All fence installers shall carry insurance coverage as required by the City.

- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed or compacted soil.
- C. Post Setting: Hand-excavate holes for post foundations in firm, undisturbed or compacted soil.
 - 1. Concrete Footings: Place concrete around posts and vibrate or tamp for consolidation. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during placement and finishing operations until concrete is sufficiently cured. Set the following post types in concrete footings and protect portion of posts above ground from concrete splatter:
 - a) Terminal.
 - b) Line; using mechanical devices to set line posts per ASTM F567 is permitted.
 - c) Gate.
 - d) Gate operator mounting.
 - 2. Pull shall not be applied to posts set in concrete until the concrete has cured for a minimum of 72 hours.
- D. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment. Terminal and gate posts shall be set in a minimum of 30" of concrete.
- E. Line Posts: Space line posts uniformly at 10 feet (3.05m) o/c. Line posts shall be set in a minimum of 24" of concrete.
- F. Intermediate Rails: Install in one piece at post-height center span, spanning between posts, using fittings, special offset fittings, and accessories.
- G. Bottom Rails: Install, spanning between posts, using fittings and accessories.
- H. Chain-link Fabric: Apply fabric to outside of enclosing framework.
- I. Tie Wires: Attach wire to chain-link fabric per ASTM F626. Tie fabric to line posts at maximum interval of 12 inches (304 mm) o/c. and to braces at maximum interval of 24 inches (609mm) o/c.
- J. When aluminum-alloy fabric is used, a tension wire shall be attached to the bottom of the fabric by means of a hog-ring type fastener at a maximum of 600mm (2 foot) intervals and secured at the terminal posts by means of a brace band.
- K. Gate Installation: Install gates level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust gate to operate smoothly, easily, and quietly throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

- L. Electrical grounds shall be constructed at each corner. A No. 6 solid copper conductor shall be clamped to the nearby ground system and to the fence in such a manner that each element of the fence is grounded. Installation of ground rods shall not constitute a pay item and shall be considered incidental to fence construction.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 WORK INCLUDED

This work shall consist of all labor, materials, equipment, and incidentals required to install all concrete work, whether plain or reinforced, as shown on the Contract Drawings.

1.02 RELATED WORK

- A. Section 02221: Trenching, Bedding, and Backfilling
- B. Section 02713: Water Distribution Systems
- C. Section 02722: Sanitary Sewer Systems

1.03 SUBMITTALS

Submit concrete mix design for each mix proposed for use identifying constituent quantities per cubic yard, including admixtures, water-cement ratio, and type of cement.

1.04 QUALITY ASSURANCE

- A. Measuring, batching, mixing, and transporting concrete shall conform to ASTM C94.
- B. Perform work in accordance with ACI 301.
- C. Conform to ACI 305 when concreting during hot weather.
- D. Conform to ACI 306 when concreting during cold weather.
- E. All detailing, fabrication, and erection of reinforcing steel shall conform to ACI 315.
- F. Reinforced concrete shall conform to ACI 318.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Water: Water used in mixing concrete shall be reasonably clean and free from objectionable substances such as oils, acids, alkalis, organic matter, clay and silt, or other deleterious substances.

- B. Portland Cement: Cement shall be domestic Portland cement and shall conform to ASTM C150. Cement shall be Type I or Type II unless otherwise specified by the Engineer. Fly ash is not an acceptable substitute for Portland cement.
- C. Fine Aggregate: Fine aggregate shall be washed, inert natural sand conforming to ASTM C33.
- D. Coarse Aggregate: Coarse aggregate shall be well-graded crushed stone or gravel conforming to ASTM C33 and shall be size No. 57.
- E. Admixtures:
 - 1. Air entraining admixtures, mandatory for concrete exposed to weather, shall comply with ASTM C260. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 - 2. Water reducing admixtures shall comply with ASTM C494, Type A. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 - 3. The use of admixtures to retard setting of concrete during hot weather and to accelerate setting of concrete during cold weather shall not be used without approval of the Engineer. Where approved, these admixtures shall comply with ASTM C494. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
- F. Steel Welded Wire Fabric: Steel welded wire fabric for reinforcement shall conform to ASTM A185.
- G. Steel Reinforcing Bars: Steel reinforcing bars shall be deformed, intermediate grade steel conforming to ASTM A615 Grade 60.
- H. Tie Wires: Tie wires for reinforcing steel shall be 16 gauge or heavier, black annealed wire.

2.02 CLASSES OF CONCRETE MIXES AND USES

- A. Select proportions of constituents to meet the design strength and material limits specified in Table I and to produce concrete having proper placability, durability, strength, appearance, and other required properties.

Class	Design psi (1)	Strength	Cement Type (2)	Cement Content (3)	W/C (4)	Slump Inches (5)	Range	Air Content % (6)
A	4000		II	564	0.45	3-5		5-7
B	3000		I	470	0.56	3-5		5-7

(1) Minimum compressive strength at 28 days in accordance with ASTM C39

(2) In accordance with ASTM C150

(3) Minimum cement content is lbs/cu. yd. of concrete

(4) Water-to-cement ratio

(5) In accordance with ASTM C143

(6) Where concrete is exposed to freeze-thaw conditions, the concrete shall be air-entrained with air content of 6% +/- 1% according to ASTM C231. Otherwise, air entrainment is not required.

- B. Concrete shall be as follows:
1. Class A concrete shall be used for all concrete work except as noted below. All reinforced concrete shall be Class A.
 2. Class B concrete may be used for thrust blocks, concrete cradles, concrete anchors, concrete caps, concrete encasement, fill concrete, and where directed on the Contract Drawings.
- C. Pumping of concrete will be permitted when approved design mix and aggregate sizes, suitable for pumping, are used.

PART 3 – EXECUTION

3.01 FORMS

- A. Construction:
1. Forms shall be mortar-tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other stresses incidental to the construction operations, including vibration.
 2. The forms shall be built true to line and grade and shall be held in place by means of studs or uprights, and whaling, which shall be sufficiently and substantially braced and tied.
- B. Form Lumber: Form lumber for all exposed concrete surfaces shall be dressed at least on one side and two edges, and shall be so constructed as to produce mortar-tight joints and smooth, even concrete surfaces.
- C. Metal Ties: Metal ties or anchorages within the forms shall be so constructed as to permit the removal to a depth of at least one inch for the face without injury to the concrete.
- D. Walls: Sufficient openings shall be provided at intervals along the bottom of wall forms to permit thorough cleaning prior to concrete placement. Such openings shall be closed before placing concrete in the forms.

- E. Surface Treatment: Prior to placing reinforcement, all forms shall be treated to prevent the adherence of concrete. Forms not provided with a special treatment shall be treated with an approved oil. Any material that will adhere to or discolor the concrete shall not be used.
- F. Metal Forms: The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt heads shall be countersunk on the face forming the concrete surface. Clamps, pins or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete.
- G. Removal of Forms: Forms shall be removed in such a manner as not to impair safety and serviceability of the structure. Concrete to be exposed by form removal shall have sufficient strength not to be damaged by removal operation.

3.02 REINFORCEMENT

- A. All reinforcement shall consist of deformed steel bars meeting the requirements of ASTM A615 Grade 60, unless otherwise indicated or directed.
- B. Steel welded wire fabric may be furnished in rolls or sheets.
- C. Reinforcing steel shall be stored above the ground surface upon platforms, skids or other supports.
- D. Reinforcing steel, where indicated, shall be accurately bent, without heating, to the forms and dimensions indicated on the plans.
- E. All reinforcement shall be furnished in the full length shown on the plans, unless otherwise approved in writing by the Engineer.
- F. Steel welded wire fabric shall be spliced by overlapping of the sheets by not less than 1-1/2 courses or 12 inches, whichever is greater, and tied together with wire ties spaced no more than 24 inches on center.
- G. All reinforcing steel, before being placed, shall be thoroughly cleaned of mill scale, rust, dirt, paint, oil, or other foreign substances or coating of any character that will reduce the bond. When there is a delay in depositing concrete after the reinforcement is in place, bars shall be re-inspected and cleaned when necessary.
- H. Unless otherwise shown, splices in reinforcing steel shall be lapped in conformity with ACI 318, but no less than 24 bar diameters. All bar splices shall be staggered where possible. When splicing bars of different diameters, the length of lap is based on the larger bar.
- I. Reinforcement shall be accurately placed and firmly held in position with metal clips or tie wire at each intersection as indicated on the plans or as directed by the Engineer.
- J. Supports for reinforcement when in contact with the foundation material shall be pre-cast concrete block bar supports or steel chairs. Maintain minimum concrete cover of 3 inches or

as indicated on the plans. In no case shall reinforcement be in contact with ground or formwork.

3.03 DRAINAGE AND WEEP HOLES

Drainage openings and weep holes shall be constructed using materials in the manner, and at the locations shown on the plans or established by the Engineer.

3.04 EXPANSION JOINTS

Expansion devices shall be as indicated on the plans.

3.05 MEASURING, BATCHING, MIXING, AND TRANSPORTING CONCRETE

- A. Measuring, batching, mixing, and transporting concrete shall conform to ASTM C94.
- B. Concrete shall be placed within 1-1/2 hours of the time at which water was first added. Otherwise, it shall be rejected.
- C. Concrete, which has been re-tempered by adding water to a ready mix truck, is the sole responsibility of the Contractor. In no case shall more than 1 gallon per cubic yard of concrete be added.

3.06 PLACING CONCRETE

- A. No concrete shall be placed until forms, reinforcing steel, condition of sub-grade and method of placement has been approved by the Engineer or the Engineer's representative. The Contractor shall advise the Engineer at least 24 hours prior to each concrete placement so that any necessary inspection or testing can be scheduled in a timely manner.
- B. Concrete shall be placed as soon as practicable following excavation for footings, slabs, and other structural components. If an extended period of time will elapse between excavation and the placement of concrete, a thin "mud mat" at least 2 inches thick consisting of low strength concrete shall be placed to protect the sub-grade from degradation due to exposure. The mud mat shall not be placed prior to sub-grade approval by the Engineer.
- C. All debris, foreign matter, loose soil, and standing water shall be removed prior to placement of concrete. Concrete shall not be placed on frozen ground.
- D. Deposit concrete as near to its final position as possible to avoid segregation due to re-handling or flowing. Movement of concrete by use of mechanical vibrators is not allowed.
- E. Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. Concrete shall not be dropped more than six feet. Tremies shall be used where drop exceeds six feet.
- F. Pumping of concrete will be permitted when an approved design mix and aggregate sizes, suitable for pumping, are used.

- G. All concrete shall be thoroughly consolidated by suitable mechanical vibrators during placement and shall be thoroughly worked around reinforcement and embedded fixtures and into corners of form.
- H. Concrete within any unit of work between construction joints shall be placed continuously so as to prevent "cold joints."
- I. If the forms show bulging or settlement while concrete is being placed, the placing shall be stopped until correction has been made.

3.07 CURING AND PROTECTION

- A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.
- B. All concrete shall be cured in conformity with ACI 301. Reinforced concrete shall additionally conform to ACI 318.
- C. Concrete placed during cold weather shall be batched, delivered, placed, cured, and protected in compliance with the recommendations of ACI 306.
- D. Concrete placed during hot weather shall be batched, delivered, placed, cured, and protected in compliance with the recommendations of ACI 305.

3.08 TESTING

- A. Field-testing of fresh concrete shall be performed by an independent testing laboratory where required by the Engineer.
- B. Unless otherwise specified, the field testing program shall, at a minimum, consist of the following activities.
 - 1. Fresh concrete shall be sampled not less than once for each concrete mix placed each day, nor less than once each 100 cubic yards of each concrete mix placed each day. Sampling shall be performed in accordance with ASTM C172.
 - 2. Ambient and concrete temperature shall be measured at the time of sampling.
 - 3. Slump tests shall be performed in accordance with ASTM C143.
 - 4. Tests for air content shall be performed in compliance with either the pressure method complying with ASTM C231 or the volumetric method complying with ASTM C173.
 - 5. A set of four compressive strength cylinders shall be molded and cured in accordance with ASTM C31.
- C. Unless otherwise specified, the break schedule for sets of four compressive strength cylinders shall be as follows: one at 7 days, two at 28 days, and one reserve. The compressive strength test shall be performed in accordance with ASTM C39.

3.09 DEFECTIVE CONCRETE

Concrete shall be placed, completed, finished, and cured so as to form a dense, compact, impervious artificial stone with smooth exposed faces. Any part of the work found to be honeycombed, porous, or otherwise defective that cannot be satisfactorily repaired, in the opinion of the Engineer, or does not meet strength requirements, shall be removed and replaced in whole or in part at the expense of the Contractor.

END OF SECTION

SECTION 11200

SEWER VALVES

PART 1 – GENERAL

1.01 WORK INCLUDED

Sewer valves and appurtenances shall be installed by the Contractor in accordance with the Contract Drawings and Specifications.

PART 2 – PRODUCTS

2.01 SWING CHECK VALVE

- A. The check valve shall be a counterweighted, rubber seated swing check valve unless otherwise specified. The valve shall permit flow in one direction only and shall close tightly without slamming when the discharge pressure exceeds the inlet pressure. The cushioned swing check valve shall be installed with the flow direction either horizontally or vertically up and shall function to prevent reverse flow. The valve shall provide a full equivalent pipe area when open fully.
- B. The valve body shall be a one-piece cast iron or cast steel casting with integral flanges. The flanges shall be faced and drilled in accordance with ANSI B16.1 Class 125 or Class 250 as shown on the Contract Drawings.
- C. The hinge shaft shall be located completely above the waterway and shall be constructed of stainless steel with the disc arm and counterweight arm keyed there on. The hinge shaft shall be one piece and shall extend through both sides of the valve body.
- D. The body seat shall be bronze or stainless steel, and the disc shall be cast iron conforming to ASTM A126 Class B. The seat ring shall be a resilient field- replaceable ring that can be replaced without the use of special tools.
- E. A lever and weight shall be provided to initiate closure unless otherwise specified.
- F. The valve shall be a Golden Anderson Series 250 or approved equal.

2.02 PLUG VALVES

- A. All plug valves shall be eccentric plug valves with 100% full port unless otherwise specified.
- B. Valves shall be of the non-lubricated eccentric type with resilient faced plugs and shall be furnished with end connections as designated on the Contract Drawings.

- C. Valve bodies shall be of ASTM A126 Class B cast iron. Bodies in 4" and larger valves shall be furnished with a 1/8" welded overlay seat of not less than 90% pure nickel. Seat area shall be raised, with raised surface completely covered with weld to insure that the plug face contacts only nickel. Screwed-in seats shall not be acceptable.
- D. Plugs shall be of ASTM A126 Class B cast iron. The plug shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. Plug shall be resilient faced with neoprene or hycar, suitable for use with sewage.
- E. Valves shall have sleeve type metal bearings and shall be of sintered, oil impregnated permanently lubricated Type 316 ASTM A743 Grade CF-8M or AISI Type 317L stainless steel. Non-metallic bearings shall not be acceptable.
- F. Valve shaft seals shall be of the multiple V-ring type and shall be externally adjustable and re-packable without removing the bonnet or actuator from the valve under pressure. Valves utilizing O-ring seals or non-adjustable packing shall not be acceptable.
- G. Valve pressure ratings shall be 175 psi through 12" and 150 psi for 14" through 72". Each valve shall be given a hydrostatic and seat test with test results being certified.
- H. Non-buried manual valves shall have hand-wheel gear actuators. Buried valves shall be provided with tee wrenches and extension stems. All valves 6" and smaller may be equipped with gear actuators. All manual actuators shall be rated for the full pressure rating of the valve. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque and to provide seat adjustment to compensate for change in pressure differential or flow direction change. All exposed nuts, bolts and washers shall be zinc plated.
- I. Valves and gear actuators for buried or submerged service shall have seals on all shafts and gaskets on the valve and actuator covers to prevent the entry of water. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs and washers shall be stainless steel.
- J. All valves shall be as manufactured by DeZURIK or approved equal.

2.03 RESILIENT SEAT GATE VALVES

- A. Resilient seat gate valves shall meet the requirements of AWWA C509.
- B. Gate valves shall have a non-rising stem with valve opening as shown on the system map in [Appendix A](#).
- C. Ends shall be mechanical joint by flanged ends suitable for use with tapping machine.

- D. Gate valves shall only be used in sewage applications where a tapped connection is made to an existing forcemain.
- E. Gate valves are not allowed for sewage applications without prior approval of the Engineer.

2.04 SEWAGE AIR AND VACUUM RELEASE VALVES

- A. All force mains shall have air and vacuum release valves installed as indicated on the Contract Drawings.
- B. Special application of the air release valves at pump station piping shall allow for a combination valve.
- C. The body of the valves shall be conical shaped to maintain maximum air gap with the spring loaded float and seal plug connection combining to ensure no contact between the sewage and the seal.
- D. The valve shall have a double float design with the upper float being enclosed in the upper section of the valve and shall be made of polypropylene.
- E. The lower float shall be in the main body of the valve and shall be constructed of 316 stainless steel.
- F. The body, cover flange, and lower flange shall be constructed of 316 stainless steel, and shall have a funnel shaped lower body to automatically drain sewage back into the system.
- G. All internal metal parts are to be made from corrosion resistant 316 stainless steel, with all operating parts in the upper section to be non-metallic plastic materials.
- H. The hinge for operation for the opening and closing of the seal on the orifice shall be made of Buna N rubber.
- I. The rolling resilient seal shall provide smooth positive opening, closing and leak-free sealing over the fluctuation of the pressure differentials.
- J. The working pressure shall be 250 psi and tested to 375 psi.
- K. All hardware shall be of stainless steel bolts and nuts, and the entire valve, except to upper outlet, shall be constructed of 316 stainless steel.
- L. The type of valve and its connection shall be installed as specified on the Contract Drawings.
- M. All air and vacuum combination release valves shall be model ARI D-020, ARI D-023, ARI D-025, or approved equal, and the automatic air release valves shall be ARI model S-020 or approved equal.

- N. All valves shall be installed in accordance with manufacturer recommendations and shall have an isolation valve connection for control.

2.05 PUMP STATION AIR VALVES

- A. Special application of the air release valves at pump station piping shall allow for a combination valve.
- B. These valves are to be located as shown on the Contract Drawings.
- C. The body/base of these valves shall be made from 316 stainless steel and all operating parts shall be made of engineered corrosion resistant plastic materials.
- D. The rolling resilient seal shall provide smooth positive opening, closing, and leak free sealing over the fluctuation of pressure differentials. The valve shall be designed to allow larger than normal automatic orifice providing efficient air release and minimize potential debris build up and clogging.
- E. The working pressure shall be 250 psi.
- F. All air and vacuum release valves shall be model ARI D-020 or ARI D-023 as per the Contract Drawings.
- G. The connection to the system shall be a direct threaded connection on the top of the pipe with a saddle and isolation valve.

2.06 PUMP STATION BYPASS PORT FITTINGS

- A. Each pump station shall be equipped with pump bypass port fittings and valves of the size and quantity as shown on the Contract Drawings.
- B. Grinder and suction lift station emergency pump port installations shall generally include an isolation valve on the common discharge line, a tee with valve and a 90° elbow with a threaded end and cap. The pump port side of the tee shall be 4-inch or 6-inch in diameter. The isolation valves shall be installed in valve boxes and the pump port shall be installed inside a 2-inch meter box. A minimum of 6 inches of crushed stone gravel shall be placed beneath the meter box.
- C. Submersible lift station emergency pump port installations shall generally include an above-ground flanged ball male discharge connection instead of the threaded port. A flanged female suction fitting connected with the wet well shall be installed where indicated on the Contract Drawings. Quick-connect fittings shall be of the ball and socket design securely seated by O-ring for a vacuum-tight seal. Quick connects shall be capable of up to 30° articulation. Couplings shall be galvanized and manufactured to ASA 150 flange patterns. Male fitting shall be provided with a lever-locking haw, which can be secured with a locking pin to prevent accidental or deliberate uncoupling. Quick-connect fittings shall be manufactured by Bauer, Wil-Loc Company, or approved equal.

2.07 VALVE BOXES

- A. Buried valves shall be installed in cast iron, 2-piece or 3-piece, screw type valve boxes with a shaft diameter of not less than 5 inches. The base shall be of such size as to permit its installation without allowing it to come in contact with either the valve or the pipe. Valve boxes shall be the heavy roadway type equipped with a cover containing the word "SEWER" in raised letters on the top and shall be John Bouchard 562-S or equal.
- B. In paved areas, the top of the box casting shall be made level with the adjacent pavement. In unpaved areas, the box shall be level with the adjacent ground and encircled with a concrete collar 4 inches thick and 24 inches in diameter. Pre-cast concrete valve collars may also be used around valve boxes.
- C. Minimum 3-inch diameter brass or aluminum valve markers shall be anchored in the concrete valve collars. The markers shall be stamped or engraved with the valve size (in inches), valve type (P.V. for plug valve, G.V. for gate valve) and opening direction (O.L. or O.R.). Valve markers are available from Wagco Marker in Longwood, Florida.

2.08 VALVE VAULTS

- A. Reinforced concrete vaults with double leaf aluminum access hatches shall be installed as sized and where indicated on the Contract Drawings.
- B. All concrete used in connection with the construction of precast concrete vaults shall be at minimum 4,000 psi concrete. The precast manufacturer shall use XYPEX additive. XYPEX ADMIX C-1000/dye shall be added to the concrete during batching at a rate of 2-3 percent by weight of Portland cement. The amount of cement shall remain the same and not be reduced. Precast concrete structures shall have a reddish tint to verify the XYPEX admix.
- C. The vault shall be self-draining by gravity sump and drain line or shall have a minimum 6-inch crushed stone bottom as indicated on the Contract Documents.
- D. The vault shall include a double leaf aluminum access frame and cover consisting a ¼-inch thick one-piece, mill finish, extruded aluminum frame, incorporating a continuous concrete anchor. Door panels shall be ¼-inch aluminum diamond plate, reinforced to withstand a uniform live load of 300 psf with a maximum allowable deflection of 1/150 of the span. Doors shall open to 90 degrees and automatically lock with T-316 stainless steel hold open arms with aluminum release handles. Doors shall close flush with the frame. Hinges and all fastening hardware shall be T-316 stainless steel. Unit shall lock with a non-corrosive locking bar and have a non-corrosive handle. Unit shall carry a lifetime guarantee against defects in material and/or workmanship. The unit shall be the S2R series as manufactured by Halliday Products, Inc, or equal.
- E. Each installation shall have steps conforming to ASTM C478 and shall be made of copolymer polypropylene plastic conforming to the latest revision of ASTM D-4101 and shall have a ½-inch diameter Grade 60 Steel reinforcing rod meeting the latest revision of ASTM A615 through its center. Each step shall be 12 inches in width and capable of supporting a load of 1,000 pounds in the center of the step when projected 6 inches from the wall. Each step shall

be equipped with non-skid grooves. Rung spacing shall be 12 inches. The location of the steps shall be coordinated with the access hatch provided.

- F. Pipe openings shall include watertight resilient pipe connectors as specified in Section 02722, Paragraph 2.13.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION

- A. Valves shall be installed per manufacturer's recommendations.
- B. Buried valves shall be installed with a cast iron valve box.
- C. Check valves shall not be mounted in wet well but shall be mounted in a valve vault as shown on Contract Drawings.
- D. Air release and vacuum valves shall be installed in a 48-inch diameter pre-cast manhole with a minimum depth of 48 inches, but with sufficient depth to accommodate the specified valve. A standard traffic casting with cover marked "Sanitary Sewer" shall be installed on the manhole. At least 1 cubic yard of stone shall be installed around pipeline.
- E. Buried valves shall include mechanical joint ends. Valves for aboveground or vault installation shall include flanged ends.
- F. Valves shall be plumbed for level installation so as not to place end connection in a bind.
- G. Air release and vacuum valves shall be mounted with a tapping boss or tapping saddle with either a brass or bronze isolation valve that includes hand controls. No galvanized piping shall be used.

END OF SECTION

SUBMERSIBLE SEWAGE PUMP STATIONS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. The Contractor shall provide and install a complete submersible sewage pump station as shown on Contract Drawings. The pump station shall be complete with all equipment shown on the Contract Drawings and as specified herein.
- B. The principle items of equipment to be furnished for the pump station shall include submersible non-clog sewage pumps, motors, internal and external piping, pump accessories, bypass pump ports, and valves; concrete wet well and valve vaults with access hatches; control panel with circuit breakers, motor starters, automatic pump control system, and other components as required; all internal and external wiring and appurtenances necessary to provide an operating pump station.
- C. Where indicated on the Contract Drawings, the pump station shall also include water service to the site, a paved access road, fencing, lighting, emergency motor generator, odor control, flow meter and other instrumentation, telemetry and other items.
- D. Where the required power supply does not exist, the Contractor shall coordinate with the appropriate power company to route the power supply to the site.

1.02 REFERENCES

- A. ANSI B16.1: Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- B. ASTM A48: Gray Iron Castings.
- C. ASTM A276: Stainless and Heat-Resisting Steel Bars and Shapes.
- D. ASTM A311: Steel Bars, Carbon, Stress-Relieved Cold-Drawn, Subject to Mechanical Property Requirements.
- E. ASTM A532: Abrasion-Resistant Cast Irons.
- F. ASTM A576: Steel Bars, Carbon, Hot-Wrought, Special Quality.
- G. The Hydraulic Institute Standards.

1.03 GENERAL

- A. Make certain that equipment does not exceed space allocation, including hatch openings, and provide the manufacturer with Contract Drawings where necessary.
- B. Pumps must operate at specific speeds below the “Upper Limits of Specific Speeds” established by the Hydraulic Institute so that the pumps may operate at the stated capacity, head, and suction lift with reasonable assurance of freedom from cavitation.
- C. Pumps, motors and control equipment shall conform to the requirements set forth in the following pages as to capacity, head, and other requirements. Motors shall be of ample size to operate without overload through the entire range of the pump characteristic curve. Ample means of lubrication shall be provided for all bearings and parts where required. Alemite industrial type fittings shall be used for grease lubrication. Pumps and motors shall perform the work intended without undue wear and undue heating.
- D. Asbestos shall not be in any part of the pumps or in the seals.

1.04 TESTS

- A. Factory Test: Each pump and motor shall be given the following tests at the factory prior to shipment:
 - 1. The mechanical and electrical integrity of the pump shall be established by the use of physical inspection and the use of a megger for verification of the stator resistance to short circuit.
 - 2. The power leads shall be connected to the motor in accordance to the jobsite voltage and the pump started to verify rotation and no load amp readings.
 - 3. The pump shall be installed in a test tank on a wet pit discharge elbow and complete hydraulic tests conducted. The KW input, power factor, flow rate and head shall be measured and recorded. The pump shall be operated at the duty point for the project and checked for compliance with Hydraulic Institute Standards prior to being certified. The pump shall then be removed and given a physical inspection and additional megger insulation test to re-verify the mechanical and electrical integrity.
 - 4. Certified copies of the results of the pump performance tests run in the factory shall be submitted to the Owner for approval prior to pump delivery.
- B. Field Test: Operate equipment for a period of five (5) successive 24-hour days prior to request of Substantial Completion. Should the equipment fail to operate as prescribed, the equipment shall be repaired and the field test procedures shall be repeated until the equipment operates as required by these documents.

1.05 WARRANTY REQUIREMENTS

- A. All equipment supplied under this section shall have a base warranty from the Contractor and each equipment manufacturer covering a period of one year from start-up. The warranty period for the station’s equipment shall commence on the date of start-up.

- B. The equipment shall be warranted free from defects in workmanship, design and materials. If any part of the equipment should fail during the basic warranty period, it shall be repaired at no additional cost to the Owner.

1.06 SUBMITTALS

- A. The submittals required in this section include (but are not limited to) the following:
 - 1. Certified characteristic pump curves
 - 2. Components and component materials of construction
 - 3. Seal descriptions
 - 4. Impeller diameter
 - 5. Maximum impeller permissible
 - 6. NPSH requirements
 - 7. Operating point
 - 8. Certified pump test
 - 9. Electrical characteristics of motors
 - 10. Manufacturer's standard recommended start-up report form
 - 11. Printed warranty
 - 12. Outline dimensions
 - 13. Layout and operation of control panel
- B. The Contractor shall submit for approval complete characteristic curves of the pumps before fabrication is started. Curves shall also indicate required NPSH, efficiency, horsepower, maximum diameter impeller that can be installed in the pump, and proposed impeller diameter for the application.
- C. Any equipment submittals for manufacturers other than those specified must be approved in all respects by the Owner to meet the proposed requirements.

1.07 ACCEPTABLE MANUFACTURERS

- A. ITT Flygt
- B. ABS

PART 2 - PRODUCTS

2.01 SUBMERSIBLE, NON-CLOGGING SEWAGE PUMPS

- A. The specifications contained herein are patterned around pumps manufactured by ITT Flygt. Products manufactured by Flygt shall set the minimum standard of quality. Some modifications to the specifications have been made to allow other manufacturers to be considered, provided their equipment is judged equal by the Owner and they are listed as approved in the original Contract Documents or by an Addendum.

- B. Furnish and install submersible non-clog wastewater pump(s) as shown on the Contract Drawings and specified herein. The pumps shall be totally submersible solids handling centrifugal pumps with submersible close-coupled motors. The overall pump design shall combine high efficiency, low required NPSH, large sphere passage and the ability to handle high solids concentrations efficiently. The impeller/casing design shall result in a passage free of surfaces to which solid or fibrous materials can adhere.
- C. Discharge Connection: The pump shall be supplied with a mating cast iron discharge connection and be capable of delivering flow and total dynamic head as specified by the Engineer. The pump casing shall have a machined connection system to attach to the ASTM A48, Class 30 cast iron discharge connection. The sealing system shall consist of two machined metal-to-metal flanges form fitted to the machined discharge coupling to insure and guarantee a positive leak-proof system and to provide ease of pump removal. The discharge connection shall be bolted to the floor of the sump with 316 stainless steel J-bolt connections and shall be designed so as to receive the pump connection without the need of any bolts, nuts or other fastenings.
- D. Guide Bars and Brackets:
1. A sliding guide bracket shall be an integral part of the pumping unit. The pump(s) shall be tightly sealed against the discharge connection to provide a non-leaking connection and shall be accomplished automatically by a simple linear downward motion of the pump with the pumping unit guided by no less than two 316 stainless steel guide bars extending from the top of the station to the discharge connection. No portion of the pump shall bear directly on the sump floor.
 2. Intermediate guide bar brackets fabricated of 316 stainless steel shall be furnished and installed so that the maximum length of unsupported guide bars will be no longer than 20 feet.
 3. The pumps shall be designed to be easily removed from their discharge connections and the wet well for inspection and maintenance. Lifting the pumps from their discharge connections and the wet well shall require neither the removal of any bolts, nuts or other fastenings nor the need for personnel to enter the wet-well.
- E. Lifting System: Each pump shall be fitted with a stainless steel chain or stainless steel cable safely rated to lift the pump from the wet well. The working load of the lifting system shall be 50% greater than the pump unit weight. The length of the lifting chain or cable shall be at least equal to the wet well depth (top slab finished grade to wet well bottom) plus 2 feet to permit raising the pump for inspection and removal.
- F. Pump Construction:
1. Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.
 2. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Fittings will be the result of controlled

- compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.
3. No secondary sealing compounds, elliptical O-rings, grease, or other devices shall be used.
- G. **Cooling System:** Motors are sufficiently cooled by the surrounding environment or by submergence in the pumped media. A water cooling jacket is not required. If a dry pit application is specified, a self-contained cooling system shall be included.
- H. **Submersible Power Cable:** The power cable shall be sized according to the NEC and ICEA standards and have P-MSHA Approval and shall be suitable for submersible pump applications. Submersible power cables shall be of sufficient length so that the cables will be continuous between the cable entry junction chamber at the motor and the control panel without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.
- I. **Cable Entry Seal:** The cable entry seal design shall preclude specific torque requirements to ensure a watertight and submersible seal. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top.
- J. **Motor:**
1. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation is not acceptable. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty while handling pumped media of 40°C (104°F) and shall be capable of at least 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.
 2. The motor service factor (combined effect of voltage, frequency, and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus

- 10%. The motor shall be designed for continuous operation in up to 40°C (140°F) ambient and shall have a NEMA Class B maximum operating temperature rise not to exceed 80°C. A motor performance chart shall be provided upon request exhibiting curves for motor torque, current, power factor, input/output kW and efficiency. The chart shall also include data on motor starting and no-load characteristics.
3. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.
- K. Bearings: The integral pump/motor shaft shall rotate on two bearings. Motor bearings shall be sealed and permanently grease-lubricated with high-temperature grease. The upper bearing shall be a single roller bearing. The lower bearing shall be a two-row angular contact bearing to compensate for axial thrust and radial forces.
- L. Mechanical Seal
1. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating, corrosion-resistant ring. The upper secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating, corrosion-resistant seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing. The position of both mechanical seals shall depend on the shaft.
 2. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate dry without damage while pumping under load.
 3. Seal lubricant shall be FDA approved and nontoxic.
- M. Pump Shaft: Pump and motor shaft shall be a single-piece unit. The pump shaft is an extension of the motor shaft. Shafts using mechanical couplings shall not be acceptable. The shaft shall be ASTM A-479 stainless steel.
- N. Impeller: The impeller(s) shall be of gray cast iron, ASTM A-48 Class 35B, dynamically balanced, semi-open multi-vane, back swept, screw shaped, non-clog design. The impeller(s) shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. Impeller(s) shall be locked to the shaft, held by an impeller bolt, and treated with a corrosion inhibitor. All impellers shall be coated or hardened to provide long life.

- O. Wear Rings: A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a brass, or nitrile rubber-coated steel ring insert that is drive fitted to the volute inlet.
- P. Volute: Pump volute(s) shall be 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.
- Q. Protection:
 - 1. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. The thermal switches shall open at 125°C (260°F), stop the motor and activate an alarm. A float switch shall be installed in the seal leakage chamber and will activate if the leakage into the chamber reaches 50% chamber capacity, signaling the need to schedule an inspection.
 - 2. The thermal switches and float switch shall be connected to a control and status monitoring unit. The unit shall be designed to be mounted in the pump control panel.

2.02 PUMP CONTROL SYSTEM

- A. Manufacturer: The electrical control components specified herein are manufactured by ITT Flygt. Products manufactured by Flygt shall set the minimum standard of quality. Other manufacturers may be considered, provided their equipment is judged equal by the Owner.
- B. General:
 - 1. A pressure transducer shall automatically start and stop the pumps, via control and time delay relays within the Pump Control Panel.
 - 2. Appropriate electrical power service shall be provided to the pump control panel. The Contractor shall coordinate this work with the appropriate power company.
 - 3. Solid-state reduced voltage starters , non-reversing shall be provided.
 - 4. Lightning and surge protection shall be provided.
- C. The control panel shall consist of a main circuit breaker, an electrically operated manual transfer switch (except where automatic transfer switches are required for dedicated emergency motor generators), a motor circuit protector, and full voltage starter for each pump motor, a 480-volt primary-120/240 volt control power transformer (fused on primary and secondary), and 20-ampere, 120-volt and 240-volt circuit breakers as required. Size transformer for actual loads plus an additional 50% spare capacity. A low and high level alarm and pump shut-off shall be accomplished by a pressure transducer liquid level control system with all control components mounted in one common enclosure. Control switches shall provide means to operate each pump manually or automatically. When operated in the automatic mode, the control assembly shall provide means to manually select or automatically alternate the position for the sets of pumps after each pumping cycle.
- D. A pressure transducer-type liquid level control system shall continuously monitor wet well liquid level and control operation of the low-level cut off for the pumps.
- E. Provide auxiliary dry contracts as required for remote sensing and control.
- F. Panel Enclosure:

1. The electrical control equipment shall be mounted within a pad-lockable NEMA Type 4X deadfront enclosure constructed of not less than 14-gauge 304 stainless steel and shall be equipped with quarter-turn quick-release latches with all hardware and exterior components constructed of 304 stainless steel. The enclosure shall be equipped with an inner door and shall incorporate a removable back panel on which control components shall be mounted. The back panel shall be secured to the enclosure with collar studs. The door shall be interlocked with the main circuit breaker. Crouse-Hinds Type "CGB" cable connectors shall be provided to terminate the motor and float cables in the control panel. The connectors shall be suitable for a 2-inch (minimum) conduit with a neoprene bushing suitable for the cables supplied. The enclosure shall be oversized to prevent and dissipate excess heat building up and to provide sufficient space for maintenance and removal of internal control panel equipment. The enclosures shall be floor-mount type with floor stands for mounting on a concrete pad. The interior door shall be provided with a locking feature to hold the door open.
2. Provide 20-ampere circuit breakers for the following equipment.
 - a) Alarm Light Fixture – 120 volts
 - b) GFCI Receptacle – 120 volts
 - c) Telemetry Radio Transmitter – 120 volts
 - d) Control Panel Heater – 120 volts
 - e) Control Panel Cooling Fan – 120 volts
 - f) Spare – 120 volts
 - g) Spare – 120 volts
3. Components:
 - a) All motor branch circuit breakers, motor circuit protectors, motor starters and control relays shall be of the highest industrial quality, securely fastened to the removable back panels with screws and lock washers. Back panels shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any component.
 - b) A thermal-magnetic molded case circuit breaker, Type KH as manufactured by Square D Company, or equal, shall be furnished for the main circuit breaker and service entrance disconnect. Provide a Service Entrance (SE) label. The manufacturer shall seal all circuit breakers after calibration to prevent tampering. Each circuit breaker shall be adequately sized to meet the station operating conditions. Motor Circuit Protectors (MCP) shall be molded case with adjustable magnetic trip only, Square D Class 680 "Mag-Guard" or equal. The control panel shall have a fully rated short circuit capacity of 65,000 AIC.
 - c) Except where an automatic transfer switch is required, provide an electrically operated non-automatic transfer switch in the control panel to provide for manual transfer to standby power when utility power is not available. The transfer switch shall be rated 240 volt, 3-phase, 3-pole, 4-wire with solid neutral. The transfer switch shall have an ampacity rating as shown on the Contract Drawings. The transfer switch shall be equal to ASCO Series 386. The standby side of the transfer shall be connected to a power receptacle for connection to portable generation equipment. The power receptacle shall be the pin and sleeve type in a NEMA 4X enclosure and located on the exterior side of the control panel. Coordinate receptacle rating, configuration and manufacturer with the Owner to match the existing cord-and-plug set.

- d) A mechanical disconnect mechanism shall be installed on each circuit breaker to provide a means of disconnecting power to the pump motors.
- e) Time delay relays shall be electronic, 600 volt, 20 amp contacts, with calibrated knob operated adjustment and numerical time dial. On delay and off delay types and timing shall be as required for proper operation of the actual equipment furnished. Relays shall be Agastat Model 7012 or 7022 or equal.
- f) A 20 ampere duplex GFCI utility receptacle (15 amp circuit breaker protected) providing 120 volts, 60 Hz, single phase current shall be mounted inside the enclosure.
- g) Provide a suitable sized electric enclosure heater with pre-set thermostat.
- h) Provide a suitable sized electric cooling fan with pre-set thermostat.
- i) The control panel shall include an adjustable time delay relay to prevent pumps from starting simultaneously. Relays shall be Paragon Electric Company, Series JW or equal.
- j) Each pump shall be provided with an automatic motor insulation monitoring device. The device shall be the EMU/Metropolitan, or equal by MotoSafe. The unit shall be a completely enclosed, solid state, plug-in electronic module designed to automatically monitor the motor winding insulation resistance. Each device shall be provided with a reset button, emergency bypass switch, power-on indicator and low meg light. Each unit shall be provided with two output circuits, one rated at 3 amps for the motor starter circuit and one rated at one amp for connection to alarm devices. The unit shall be designed to operate on a 120-volt power supply.
- k) The control diagrams and overload tables shall be laminated to the inside of the exterior door.
- l) Print storage pockets shall be provided on the inside of each panel. Pocket shall be sufficient size as required to hold all prints necessary to service the equipment. A set of reduced drawings shall be provided for each panel, sized to fit in the storage pocket.
- m) The controls shall operate off a 120-volt control circuit. A transformer shall be provided.
- n) Alternators shall be provided for the control panel. Alternators shall be 008-120-13SP or 009-120-23AP as manufactured by Sta-con or equal.
- o) A phase monitor shall be provided for the control panel. Monitors shall be model SUA-440-ASA as manufactured by Diversified Electronics Inc. or equal.
- p) The control panel shall be provided with lightening and surge protection. The surge protection devices shall be mounted within the control panel enclosure. Lead lengths shall not be longer than 12 inches from the main circuit breaker. The devices shall have minimum surge current capacity rating of 80 kA per phase. The surge protection devices shall be listed in accordance with UL 1449 Second Edition and as defined by IEEE C62.41 and C62.45. The transient voltage surge suppressors shall be as manufactured by Advanced Protection Technologies (APT) for the power supply voltage:
 - TE/5XF – 480 VAC, 3-Phase
 - TE/4XF – 480/277 VAC, 3-Phase
 - TE/3XF – 120/240 VAC, 3-Phase
 - TE/2XF – 120/208, 3-Phase
 - TE/1XF – 120/240, 1-Phase

- q) All control panel wiring shall be numbered at both ends with type written heat-shrinkable wire markers.
 - r) Wiring shall be stranded copper, minimum size #14 AWG (except for shielded instrumentation cable), with 600-volt, 90-degree C, Flame-retardant, Type MTW thermoplastic insulation.
 - s) The control panel shall be provided with nameplates identifying each component, selector switches, pilot lights, etc. Nameplates shall be permanently affixed using an epoxy process (inner door nameplates shall be fastened with stainless steel screws). Nameplates shall be laminated plastic, engraved white letters on a black background.
 - t) All control panels shall be provided with a master nameplate located on the exterior door.
 - u) Where applicable, provide a nameplate that reads as follows "CAUTION – THIS PANEL CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE." Letters shall be black on a high visibility yellow background.
 - v) Corrosion Inhibitor Emitter: Inclusion of an industrial corrosion inhibitor emitter that shall protect internal components of control panel from corrosion for up to one year. One spare emitter shall be provided for each control panel.
 - w) All control relays shall have 10-amp-rated contacts (minimum), 11 pin with mounting base, 3PDT (minimum), with LED indicators to show relay status. Relays shall be manufactured by Potter Brumfield or equal.
 - x) Terminal blocks shall be 600-volt heavy-duty rated, tubular clamp type. Terminal strips shall be Allen Bradley catalog #1492-CA-1 or equal. Each terminal shall be individually labeled.
 - y) The completed control panel assembly shall be UL certified. The control panel and main circuit breaker shall be Service Entrance (SE) labeled.
 - z) Intrinsically safe relays shall be solid-state type with 5-amp output contacts, suitable for use on 120-volt, 60-hertz power supply and shall be Factory Mutual approved for devices in Class1, Division 1 hazardous atmospheres. Intrinsically safe relays shall be Gems Solid State Safe-Pak as manufactured by Gems Sensors, Division of Transamerica Delaval, Inc. or equal.
 - aa) A copper ground bar with sufficient terminals for all field and panel ground connections shall be provided.
 - bb) An 8-inch (minimum) clear space within the enclosure shall be provided horizontally along the entire top and bottom of the control panel. A 4-inch (minimum) clear space within the enclosure shall be provided vertically along the entire sides of the control panel. No devices, terminals, etc. shall be installed within this space. The space shall be provided for field conduit and wiring access only.
 - cc) Provide adequate space in the control panel for a telemetry radio transmitter to be installed by others. Provide a 120-volt circuit for radio power.
 - dd) Where included on the Contract Drawings, the pump control panel shall house the flow meter unit.
4. Operating Controls and Instruments:
- a) All operating controls and equipment shall be securely mounted on the control compartment door. All controls and instruments shall be clearly labeled to indicate function.

- b) Pump mode selector switches shall be hand-off-auto type to permit over-ride of automatic level control and manual actuation of shutdown of either pump motor. Operation of pumps in manual mode shall bypass all safety shutdown circuits except pump motor overload shutdown and low level pump shutdown via pressure transducer, back-up float switch and control relays. Switches shall be NEMA 4X as manufactured by Allen Bradley or equal providing three (3) switch positions, each of which shall be clearly labeled according to function.
 - c) Indicator lamps shall be incandescent type and mounted in NEMA 4X (800H) modules, as manufactured by Allen Bradley. Lamp modules shall be equipped to operate at 120-volt input. Lamps shall be easily replaceable from the front of the control compartment door without removing the lamp module from its mounted position. Indicators shall be provided for individual motor run and indicator for each failure condition.
 - d) A 6-digit, non-reset elapsed time meter shall be connected to each motor starter to indicate the total running time of each pump in "hours" and "tenth of hours." The elapsed-time meters shall be Series T50 as manufactured by ENM Company or equal.
 - e) A pump station lead selector hand switch shall be provided with inscriptions 1/2/ALT for the pump station lead pump selection or pump alternation (or similar for 3 or more pumps). Alternation mode selection shall alternate pumps after each run cycle. Pump alternator shall be furnished as specified herein.
 - f) A beacon light shall illuminate when there is a high wet well level alarm. The control panel shall be provided with an alarm silence pushbutton and an alarm reset pushbutton. The beacon light shall be NEMA 4X, 120 VAC, xenon strobe flasher with unbreakable, red Lexan globe, manufactured by Federal Electric Co. or equal.
5. Full Voltage Magnetic Motor Starters: The motor starters shall be mounted within the pump control panel. Motor starters shall be equal to Square D Class 8536 with "Motor Logic" solid-state overload relay protection.
6. Make provisions in the pump control panel for future telemetry system provided by the Owner, including termination blocks, as a minimum for the following I/O:
- a) Pump No. 1 run status
 - b) Pump No. 2 run status
 - c) High wet well alarm
 - d) Two pumps running
 - e) RTU signal loss/failure alarm
 - f) Power failure alarm
 - g) Pump No. 1 failure alarm
 - h) Pump No. 2 failure alarm
 - i) Spare
 - j) Spare
 - k) 4-20mA analog signal for flow rate
 - l) Spare analog signal
 - m) Additional discrete I/O as required for additional pumps
7. Where required, make provisions for flow transmitters as specified herein. Transmitter unit shall be flush mounted on the inner door of the pump panel. The

- G. Level Sensing System/Pump Control
1. General: The control system shall be designed to operate the required number of pumps specified on the drawing at the power characteristics shown on the plans. The pump control system shall utilize a current input signal, supplied from a submersible pressure transducer. The controller shall supply separate alarm outputs for each fault condition.
 2. The pump controller shall be the MultiTrode MultiSmart Controller and RTU. This product shall set the minimum standard of quality. Other manufacturers may be considered, provided their equipment is judged equal by the Owner and they are listed as approved in the original Contract Documents or by Addendum. Products of other manufacturers shall be assembled to provide all specified functions, including reliability equal to or exceeding that of the manufacturers listed above.
 3. The control function shall provide for the operation of the pumps under normal conditions, and shall alternate the pumps on each pump down cycle to equalize the run time. In the event the incoming flow exceeds the pumping capacity of the lead pump, subsequent pumps shall automatically start to handle the increased flow. As the flow decreases, the pumps shall cut off at the elevations as shown on the plans.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install base elbows with embedded anchor bolts. Use of expanding anchor bolts to secure base elbows is not permitted.
- B. Install pumps in accordance with manufacturer's instructions.
- C. Provide for connection to electrical service.
- D. Lubricate pumps before start-up.

3.02 FIELD QUALITY CONTROL

- A. Perform field inspection testing.
- B. Manufacturer's Field Services: Furnish factory-authorized service representatives to inspect equipment during installation, to assist in adjusting and testing, to supervise initial operation, and to make final adjustments as necessary to assure satisfactory operation.
- C. Minimum Length of Field Services: 2 trips, 1 day per trip, exclusive of travel time from pump manufacturer.
- D. Test pumps in presence of Owner to verify specified capacities and operating characteristics are developed.

- E. Make repairs and retest pumps and drives until specified capacities and operating characteristics are achieved.
- F. Furnish labor, piping, equipment, and materials necessary for conducting tests.

3.03 DEMONSTRATION

- A. Furnish 1 day of on-the-job instructions (exclusive of travel time) to Owner personnel on all pump-related equipment.
- B. Equipment demonstrations and instructions are in addition to other Manufacturer's Field Services specified in Article 3.02.

3.04 INSTRUCTION MANUALS

- A. Contractor shall furnish, prior to initial testing, three (3) copies of an indexed maintenance manual composed of suppliers' maintenance manuals on all equipment and suppliers' brochures on all specialty equipment, including performance curves with size, model, figure number, etc., indicated to identify unit furnished. Maintenance manuals are to be of a hardback, loose-leaf type and of a durable quality. Manuals are to be for the specific equipment provided. Manuals describing general equipment lines will not be accepted.
- B. Each set is to include the following:
 - 1. Manufacturer's parts list identified with the make, model and serial number of the equipment furnished.
 - 2. Control and wiring diagrams.
 - 3. Installation, operation, lubrication and maintenance instructions.
 - 4. Manufacturer's recommended spare parts lists.
 - 5. Certified pump curves for each pump to be owned and operated by the City.

3.05 FINAL INSPECTION

The final inspection will be performed by City personnel in accordance with the "Clarksville Gas & Water Lift Station Final Inspection Checklist" included in [Appendix F](#).

END OF SECTION

HYDRAULIC SEWAGE GRINDERS

PART 1 – GENERAL

1.01 SUMMARY

This section of the specification describes the sewage grinder, hydraulic power pack, and motor controller. The equipment shall be installed as shown on the Contract Drawings, as recommended by the supplier, and in compliance with all OSHA, local, state, and federal codes and regulations.

1.02 REFERENCES

Grinder shall, as applicable, meet the requirements of the following industry standards:

- A. ASTM A 36: Standard Specification for Carbon Steel Plate.
- B. ASTM A 536 – 84: Standard Specification for Ferritic Ductile Iron Castings.
- C. ASTM A 48-83: Standard Specification for Grey Iron Casting.
- D. AISI 303 Stainless Steel
- E. AISI 304 Stainless Steel
- F. AISI 4130 Heat Treated Alloy Steel
- G. AISI 4140 Heat Treated Hexagon Steel
- H. Rockwell C

1.03 SUBMITTALS

- A. Shop Drawings:
Supplier shall submit 3 sets of shop drawings. Shop drawings shall include equipment descriptions, specifications, dimensional and assembly drawings, parts lists, and job specific drawings.
- B. Closeout Submittals:
Supplier shall submit 3 sets of Operation and Maintenance manuals. The manuals shall include equipment descriptions, operating and maintenance instructions, drawings, troubleshooting techniques, recommended maintenance schedule, and the recommended lubricants.

1.04 QUALITY ASSURANCE

- A. Qualifications:

Qualified suppliers shall have a minimum 5 years experience at manufacturing two-shafted grinding equipment and motor controls with a minimum of 2,000 installations with similar equipment. Supplier shall provide a list of names and dates of installations for verification by the Engineer.

B. Regulatory Requirements:

Motor controllers shall, as applicable, meet the requirements of the following Regulatory Agencies.

1. National Electrical Manufacturer's Association Standards
2. National Electrical Code
3. Underwriters Laboratory

1.05 DELIVERY, STORAGE AND HANDLING

A. The equipment shall be packaged in containers constructed for normal shipping, handling and storage.

B. The containers shall provide adequate protection for the equipment in a dry indoor environment between + 40°F and + 100°F until time for installation.

1.06 IDENTIFICATION

Each unit of equipment shall be identified with a corrosion resistant nameplate, securely affixed in a conspicuous place. Nameplate information shall include equipment model number, serial number, supplier's name, and location.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Grinder, hydraulic power pack, and motor controller shall be in compliance with these specifications and Contract Drawings and shall be supplied by one of the following manufacturers:

1. JWC Environmental®: Channel Monster® single or double drum as shown on the Contract Drawings.
2. Approved equal

B. Manufacturers requesting to be included as an approved equal shall submit certified documentation showing compliance with these specifications a minimum of ten (10) days prior to bid opening. Selected equipment manufacturers shall be added to the list of approved manufacturers.

C. The manufacturer must certify that the unit can be returned for maintenance to the factory or a local repair facility. The certification shall include a statement that there will be no charge for repair labor during the one-year warranty period.

2.02 SUPPORT SYSTEM FOR IN-CHANNEL GRINDER

A. General:

A grinder support frame with adjustable mounting brackets shall be provided sized to match the channel shown on the Contract Drawings.

B. Components:

The support frame and additional supports shall be of welded square tube, angle, and plate construction. The construction material shall be 304 stainless steel.

2.03 GRINDER(S)

A. General:

1. Each Channel Monster® grinder shall include cutters, spacers, shafts, perforated screen drum, bearings and seals, side rails, end housings, covers, reducer, and hydraulic torque motor.
2. The grinder shall be of two-shaft design and be capable of continuous operation, processing wet or dry. Bar screens or single-shaft devices utilizing a single rotating cutter bar with stationary cutters shall not be acceptable. Grinders designed with cutter and spacer cartridges rather than individual cutters and spacers, shall not be acceptable.
3. Two-shaft design shall consist of two parallel shafts alternately stacked with individual intermeshing cutters and spacers positioned on the shaft to form a helical pattern. The two shafts shall counter-rotate with the driven shaft operating at approximately two-thirds (2/3) the speed of the drive shaft.
4. Rotating perforated screen drum(s) shall consist of a cylindrical perforated sheet, support rings and stub shafts. The rotating drum shall direct all solids toward and into the counter-rotating dual-shaft grinder. The drum(s) shall be driven by the grinder drive mechanism.

B. Components:

1. Individual Cutters and Spacers:
 - a) The cutting chamber shall be a nominal height as shown on the Contract Drawings.
 - b) Individual cutters and spacers shall be 4130 heat treated alloy steel, surface ground for uniformity and through-hardened to a minimum 45 – 50 Rockwell C.
 - c) The inside configuration of both the individual cutters and the individual spacers shall be hexagonal so as to fit the shafts with a total clearance not to exceed 0.015 inch across the flats to assure positive drive, minimize wear on the cutters, and increase the compressive strength of the spacers.
 - d) Cutter configuration shall consist of one shaft having 5 tooth double-edged cutters and one shaft having 11 tooth cam cutters. To maintain particle size, the height of the tooth shall not exceed ½ inch above the root diameter. Cutter to cutter root diameter overlap shall be not less than 1/16 inch or greater than ¼ inch to maintain the best possible cutting efficiency while incurring the least amount of frictional losses.
 - e) The cutters shall exert a minimum force at the tooth tip of 991 lbs/hp during momentary load peaks.

2. Shafts
 - a) Grinder drive and driven shafts shall be made of 4140 heat treated hexagon steel with a tensile strength rating of not less than 149,000 psi.
 - b) Each hexagonal shaft shall measure a nominal 2 inches across parallel surfaces.
3. Intermediate Shaft Support
 - a) An intermediate shaft support shall be provided in the center of the cutter stack for all grinders with 24-inch, 32-inch or 40-inch cutter stacks. Grinders with 50-inch or 60-inch cutter stacks shall have two intermediate shaft supports.
 - b) The intermediate shaft support shall provide additional support for heavier than normal influent grinder demand loads and protection for the seal assemblies.
 - c) The intermediate shaft support shall be made of cast 303 stainless steel collar and two bushings. The bushings shall act as bearings to allow the free rotation of the shafts.
4. Perforated Screen Drum(s)
 - a) The screen drum shall be made of 11 gage 304 stainless steel sheet. The perforated sheet shall have ¼-inch diameter holes on a 3/8-inch stagger.
 - b) The drum supports shall be constructed of 304 stainless steel. The end supports shall include stub shafts for the mounting of seal assemblies. Center support ring(s) shall provide additional structure to the center of the drums.
 - c) Drum stub shafts shall be made of 304 stainless steel with a tensile strength of not less than 95,000 psi. The shaft diameter shall be a minimum of 1-1/2-inch.
5. Shaft Bearings and Seals
 - a) The radial and axial loads of the cutter shafts shall be borne by sealed, oversized, deep-groove ball bearings at each end.
 - b) The bearings shall be protected by a combination of a replaceable and independent tortuous path device and mechanical seals.
 - c) Face materials shall be of tungsten carbide to tungsten carbide.
 - d) O-rings shall be made of Buna-N elastomers.
 - e) Products requiring continuous or occasional lubrication or flushing shall not be accepted.
 - f) The mechanical seal shall be rated at 90 psi continuous duty by the seal supplier.
 - g) The bearings shall be housed in a replaceable cartridge that supports and aligns the bearings and seals, as well as protects the shafts and end housings. The seal elements shall be independent of the stack height and cutter stack tightness shall not affect seal performance. The seal elements shall maintain their factory set preload independent of the cutter stack tightness.
 - h) Seals shall meet required pressure rating regardless of cutter stack fit. The seal cartridge shall provide seal protection against axial loading on shafts and bearings during shaft deflection.
 - i) Each seal element shall be positively locked to its corresponding rotating or static cartridge element. This positive lock on the seal elements is critical to long seal life in applications where grit or other abrasive materials are present.
6. Cutter Side Rail
 - a) The inside profile of the cutter side rail shall be concave to follow the radial arc of the cutters.

- b) Clearance between the major diameter of the cutters and the concave arc of the side rails shall not exceed 5/16 inch.
 - c) The cutter side rails shall have evenly-spaced slots that increase flow and decrease head loss.
 - d) The side rails shall be cast of A 536-84 ductile iron.
7. Drum Side Rail
- a) The inside profile of the drum side rail shall be concave, with an adjustable UHMW plastic extension strip to minimize clearance at the front of the drum. This clearance shall not exceed 1/16-inch from the major diameter of the perforated screen drum.
 - b) The drum side rail shall be cast of A 536-84 ductile iron.
8. End Housings and Covers
- a) Grinder end housings shall be cast A 526-84 ductile iron with a cast-in-place flow deflector, designed to protect the bushings while guiding particles directly into the flow chamber.
 - b) Top covers shall be A 536-84 ductile iron and bottom covers shall be A36 hot rolled plates.
9. Hydraulic Motor: The grinder motor shall be a low-speed, high-torque, rotary-power hydraulic torque motor that utilizes the hydraulic pressure developed by the hydraulic power pack.
10. Required Running Torque per Horsepower: Momentary Load Peaks at 2,298 in-lbs/hp.

2.04 GRINDER HYDRAULIC POWER PACK

A. General

1. The hydraulic power pack shall provide hydraulic pressure and flow to operate the grinder. The hydraulic power pack shall provide pressure, temperature, and level outputs to the controller. The power pack and grinder hydraulic motor shall be designed for smooth operation during frequent starts, stops and reversals.
2. The entire hydraulic system shall be designed for 3,000 psi maximum pressure. Under no load conditions the system operating pressure shall be in the 200 to 400 psi range. Continuous operating pressure greater than 2,000 psi shall not be acceptable.
3. As solids are encountered, pressure shall be automatically increased on a demand basis providing the required torque necessary to continue rotation of the cutters.
 - a) Should an obstruction cause the grinder demand pressure to exceed 2,850 psi, a pressure switch shall be activated and a 2-way valve shifted. The rotation of the cutters shall immediately reverse for about one-half (1/2) to one (1) revolution. Following this, the valve shall be shifted and the cutters returned to forward rotation.
 - b) When the obstruction is cleared the unit shall continue to operate in the forward direction.
 - c) If the obstruction is not cleared, the reversing sequence shall repeat until the obstruction is cleared or 9 reversals have occurred within 45 seconds. If the reversing sequence has completed and the obstruction has not been cleared, the controller shall de-energize the hydraulic power pack electric motor and activate an overload relay and a fail indicator.
4. The hydraulic power pack shall be rain-resistant and suitable for mounting in a remote location, as required by design parameters of the project.

B. Components:

1. Power packs shall include the following components:
 - a) 16-inch x 16-inch x 15-inch, epoxy coated, 10 gallon U.S. capacity reservoir.
 - b) Suction strainer.
 - c) Positive displacement pump driven by a vertically mounted 5 hp, TEFC, C face, electric motor.
 - d) Relief valve preset at 3,000 psi.
 - e) 2-1/2-inch, 0 to 5,000 psi oil filled gauge.
 - f) Pressure switch present at 2,850 psi.
 - g) 110 volt two-port directional valve.
 - h) High pressure return line filter.
 - i) Combination oil level and oil temperature gauge.
 - j) Combination oil level switch and oil temperature limit switch.
 - k) Temperature switch set at 160°F.
 - l) Filler breather.
 - m) Electrical enclosure.
2. Hydraulic connections between the torque motor and the power pack shall consist of two, ½ inch flexible hoses.
 - a) The flexible hoses shall be rated for a minimum 3,500 psi working pressure with a 14,000 psi burst pressure.
 - b) The hose pressure loss between the hydraulic power pack and the grinder torque motor shall not exceed 150 psi at 50°F above ambient temperature.
3. The hydraulic power pack shall be filled with a high quality hydraulic fluid.
 - a) The hydraulic fluid shall have a viscosity of approximately 100 to 250 SSU at 100°F with good chemical stability and anti-foaming properties.
 - b) The grades of hydraulic fluid shall be in accordance with the supplier's recommendations.

2.05 MOTOR CONTROLLER

A. General:

1. The controller shall provide independent control of the hydraulically driven grinder.
2. Controller shall be the supplier's standard UL/cUL listed Model PC2240.
3. The controller shall be rated for 5 hp, 480/230 volts, 3-phase, 60 Hz.

B. Operation:

The controller shall be equipped with a GRINDER ON-OFF/RESET-AUTO three (3) position selector switch.

1. In the OFF/RESET mode the grinder shall not run. In the ON mode the grinder will run.
2. In the AUTO mode the grinder shall start and stop as controlled by a remotely-located dry contact.
3. The grinder shall only be reset by switching the GRINDER ON-OFF/RESET-AUTO switch to the OFF/RESET position.

C. Safety Features:

1. When a grinder jam condition occurs in the grinder ON or AUTO mode, the controller shall stop the grinder, and then reverse the grinder rotation to clear the obstruction. If the jam is cleared, the controller will return to normal operation. If the jam condition still exists, the controller will go through eight additional reversing cycles within 45

seconds (nine times total) before signaling a grinder overload condition. Upon a grinder overload condition, the controller will shut the grinder off and activate an overload contact.

2. If a power failure occurs while the grinder is running, operation will resume when power is restored.
3. If a power failure occurs while the grinder is in a fail condition, the fail indicator shall be reactivated when power is restored.
4. The controller shall provide overload protection for the motor through an overload relay mounted directly on the grinder starters.
5. Short-circuit protection requires that a properly sized circuit breaker or fuses be installed by others.
6. Controller reset shall be from the local panel controls only.

D. Components

1. Enclosure
 - a) Enclosures shall be NEMA 4X, fabricated of fiberglass-reinforced polyester resins, and shall be suitable for wall mounting. Doors shall have hinges and corrosion resistant latches.
 - b) Enclosure shall house the control devices, relays, terminal blocks, and grinder non-reversing hydraulic power pack oil pump motor starter.
2. Control Devices
 - a) Operator interface and pilot devices shall be mounted on the enclosure front panel door.
 - b) The controller shall have indicator lights for GRINDER RUN, and FAIL.
 - c) Indicator lights shall be of an integral-transformer type with 6-volt lamps. Lamps and the selector switches shall be heavy duty NEMA 4X type.
 - d) Control transformer shall be protected by two primary fuses and one secondary fuse. The 120-volt secondary shall have one leg grounded.
 - e) Relay contacts shall be included for GRINDER RUN and FAIL signal outputs. The contacts shall be rated 10 amp, 240 VAC, resistive load.
3. Motor Starter
 - a) A non-reversing contactor type motor starter shall be provided for the hydraulic power pack oil pump motor.
 - b) Overload relay (OL) shall be adjustable so that the range selected includes the FLA (full load amperes) rating and service factor.

2.06 SOURCE QUALITY CONTROL

Each grinder, hydraulic power pack, and controller shall be factory tested to ensure satisfactory operation.

PART 3 – EXECUTION

3.01 INSTALLATION

Grinder, hydraulic power pack and motor controller shall be installed in accordance with the supplier's installation instructions, and in compliance with all OSHA, local, state, and federal codes and regulations.

3.02 FIELD QUALITY CONTROL

Supplier shall provide 1 day of services of a factory-trained representative to check the installation and to start-up each grinder and controller. The factory representative shall have complete knowledge of proper installation, operation, and maintenance of equipment supplied. Representative shall inspect the final installation and supervise a start-up test of the equipment. Representative shall also train Owner personnel in the operation of the grinder.

END OF SECTION

WET WELL MOUNTED, SUCTION LIFT SEWAGE PUMP STATIONS WITH DUPLEX PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Contractor shall furnish and install factory-built, automatic pumping stations as described herein and as manufactured by Smith & Loveless, Inc. Each station shall be complete with all needed equipment, factory installed on a welded steel baseplate with fiberglass cover as shown on the Contract Drawings.
- B. The principal items of equipment shall include two vertical, close-coupled, motor driven, vacuum primed, non-clog sewage pumps; valves; internal piping; central control panel with circuit breakers, motor starters and automatic pumping level controls; heater, ventilating blower, priming pumps and appurtenances, and all internal wiring.

1.02 OPERATING CONDITIONS

- A. Each station shall be equipped with pumps capable of delivering the flows of wastewater against the total dynamic heads indicated on the Contract Drawings and at the efficiencies specified. Operating Design Points will be developed for each specific application. Hydraulic calculations will be required to demonstrate the methods used to determine the design point.
- B. All openings and passages shall be large enough to permit the passage of a sphere 3" in diameter and the pump shall have a flanged suction and discharge connection no smaller than 4".
- C. The pump motors shall not be overloaded beyond their nameplate rating at the design conditions nor at any head in the operating range.

1.03 MANUFACTURED EQUIPMENT EVALUATION

- A. The specifications and drawings detail Smith & Loveless equipment and represent the minimum standard of quality for both equipment and materials of construction.
- B. Substitution of other makes may be considered if the equipment proposed for substitution is superior or equal in quality and efficiency to the standards of quality named in the specifications and is demonstrated to the satisfaction of the Owner.
- C. Contractors wishing to substitute equipment shall include the following submittal information with their proposal. This submittal shall include all necessary information for the proper determination of the acceptability of the proposed substitution and shall not necessarily be limited to the following:

1. Complete description of the equipment, system, process or function, including a list of system components and features, drawings, catalog information and cuts, manufacturer's specifications, including materials descriptions.
 2. Performance data and curves, and horsepower requirements.
 3. Outside utility requirements, such as water, power, air, etc.
 4. Functional description of any internal instrumentation and controls supplied including list of parameters monitored, controlled or alarmed.
 5. Addresses and phone numbers of nearest service centers and listing of the manufacturer's or representative's services available at these locations, including addresses and phone numbers of the nearest parts warehouses capable of providing full parts replacement and/or repair services.
 6. A list of five installations in the states where similar equipment by the manufacturer is currently in similar service; include contact name, telephone number, mailing address of the municipality or installation; Engineer, Owner, and installing Contractor. If five installations do not exist, the list shall include all that do exist, if any.
 7. Detailed information on site, architectural, structural, mechanical, plumbing, electrical and control, and all other changes or modifications to the design and construction work necessary to adapt the equipment or systems to the arrangement shown and/or functions described on the Contract Drawings and in the technical specifications. This shall include plan view and section sketches illustrating any additional space requirements necessary to provide the minimum adequate clear space within and around the equipment for operation and maintenance, as shown on the drawings and specified.
 8. All differences between the specifications and the proposed substitute equipment shall be clearly stated in writing under a heading of "differences".
 9. Other specific submittal requirements listed in the detailed equipment and material specifications.
- D. Approval of the substitution as an alternate shall in no way relieve the Contractor from submitting the specified shop drawings for approval or complying fully with all provisions of the specifications and drawings. If substituted equipment is accepted, the Contractor shall, at his own expense, make any changes in the structures, piping, electrical, etc. necessary to accommodate the equipment. If engineering is required due to substitution of alternate equipment, the Contractor shall pay for all engineering changes. To receive final consideration, copies of the manufacturer's quotations for the equipment may be required to document the savings to the satisfaction of the Engineer. It is the intent that the Owner shall receive the full benefit of the savings in cost of the equipment and the Contractor's bid price shall be reduced by an amount equal to the savings. In all technical and other evaluations, the decision of the Engineer is final.

1.04 WARRANTY

- A. The manufacturer of the pump station shall guarantee the structure and all equipment to be free from defects in materials and workmanship for a period up to one year from the date of start-up, not to exceed 18 months from the date of shipment. Warranties and guarantees of suppliers of various components in lieu of a single source responsibility by the pump station manufacturer will not be accepted. The pump station manufacturer shall be solely responsible for the guarantee of the station and all components.

- B. In the event a component fails to perform as specified or is proven defective in service during the guarantee period, the pump station manufacturer shall provide a replacement part without cost to the Owner. He shall further provide, without cost, such labor as may be required to replace, repair or modify major components such as the steel structure, pumps, pump motors, suction and discharge piping and valve assembly.

PART 2 – PRODUCTS

2.01 STATION

- A. All openings and passages shall be large enough to permit the passage of a sphere 3” in diameter. The station shall be constructed in one complete, factory-built assembly. It shall be sized to rest on the top of the wet well as detailed on the Contract Drawings.
- B. The supporting floor plate shall be a minimum 3/8” thick steel with reinforcing, as required, to prevent deflection and ensure an absolutely rigid support. Steel plate shall meet or exceed ASTM A36 specifications.
- C. The pump volutes and discharge piping shall be mounted in relation to the floor plate as detailed in the Contract Drawings. The suction and discharge connections, where they pass the floor plate, shall be sealed by gaskets rather than being welded to allow adjustment and replacement.

2.02 FIBERGLASS COVER

- A. The pump station shall be enclosed by a hinged fiberglass cover made of molded reinforced orthophthalic polyester resins with a minimum of 30% glass fibers with a minimum average length of 1-1/4”. The outside of the enclosure shall be coated with a polyester protective in-mold coating for superior resistance to weathering, ultraviolet radiation, yellowing and chalking. The completed fiberglass cover shall be resistant to mold, mildew, fungus and corrosive liquids and gasses normally found in pump station environments.
- B. The dimensions of the enclosure shown on the Contract Drawings shall be considered for internal component clearances and accessibility and nothing smaller will be acceptable. The cover shall have a suitable drip-lid around the edge and shall be provided with a hasp and staple connection to the floor plate to allow the pump chamber to be locked with a padlock.
- C. The cover shall be attached with a multi segment stainless steel hinge, constructed of 7 gauge (minimum) type 304 stainless steel with a 3/8” diameter stainless steel pin and supporting at least 75% of the width at one end. Stainless steel bolts with tamperproof

heads and a full width 3/8” thick anodized aluminum backing plate shall anchor the hinge to the fiberglass cover. Dual high pressure gas struts shall be provided to counteract the dead weight of the cover assembly and limit the maximum lifting force required for opening to less than 20 pounds. The cover shall be self-latching upon opening, with a manually operated

release for closing. Duplex heavy gauge safety chains shall be provided to prevent over extension.

- D. All hardware and components of the cover assembly which are exposed to the weather shall be constructed of corrosion resistant materials. Heavy extruded aluminum adjustable louvers shall be provided on each end of the fiberglass cover, which are capable of being closed during cold weather operation.

2.03 MANWAY

- A. An aluminum manway cover fabricated of 1/4" treadplate, located exterior to the fiberglass pump chamber shall be provided, complete with padlocking provisions. The manway shall be an integral part of the pump station floor and shall provide access to the wet well. The minimum open area of the manway access into the wet well shall be at least 4.2 square feet.
- B. The manway cover shall have a three color 7"x10" (minimum) corrosion resistant sign permanently affixed to it, reading "DANGER – Before Entering, Test for Explosive Gasses. Test for Oxygen Deficiency. Supply Fresh Air to Work Area."

2.04 LIFTING ARM

To allow on-site maintenance of the pumps, a stanchion with lifting arm shall be provided to lift each pump. The stanchion requirement will apply to both vertical and horizontal pumps, whichever is supplied by the installing Contractor. The lifting arm shall have a hook over the center of the motor to support a hoist for removal of the motors, impellers and pumps from the station.

2.05 WELDING

All steel structural members shall be joined by electric arc welding with welds of adequate section for the joint involved. Structural welding shall be performed in accordance with AWS standards and procedures.

2.06 CORROSION PROTECTION

After welding, all inside and outside surfaces of the structure shall be blasted with steel grit to remove rust, mill scale, weld slag etc. All weld splatter and surface roughness shall be removed by grinding. Immediately following the cleaning, a single heavy inert coating shall be factory applied to all inside and outside surfaces prior to shipment. This coating shall be Versapox epoxy resin specially formulated for abrasion and corrosion resistance. The dry coating shall contain a minimum of 86% epoxy resin with the balance being pigments and thixotropic agents.

2.07 MAIN PUMPS

- A. The pumps shall be 4" vertical, non-clog type of heavy cast iron construction, especially designed for the use of mechanical seals and vacuum priming. In order to minimize seal wear caused by linear movement of the shaft, the shaft bearing nearest the pump impeller shall be locked in place so that end play is limited to the clearing within the bearing.

- B. To minimize seal wear resulting from shaft deflection caused by the radial thrust of the pump, the shaft from the top of the impeller to the lower bearing supporting the impeller shall have a minimum diameter of 1-7/8" for motor sizes 1.5 H.P. through 15 H.P. (motor frame sizes 213 through 286); 2-1/8" for motor sizes 20 H.P. through 30 H.P. (motor frame sizes 324 and 326); and 3" for motor sizes 40 H.P. and larger (motor frame sizes 364 and larger). The dimension from the lowest bearing to the top of the impeller shall not exceed 6".
- C. The bearing nearest the impeller shall be designed for the combined thrust and radial load. The upper bearing shall be free to move linearly with the thermal expansion of the shaft and shall carry only radial loads. The shaft shall be solid stainless steel through the pump and bottom bearing to eliminate corrosion within the pump or the mechanical seal. Removable shaft sleeves will not be acceptable if the shaft under the sleeve does not meet the specified minimum diameter.
- D. The pump impellers shall be of the enclosed type made of close-grained cast iron and shall be balanced. The impeller shall be keyed with a stainless steel key and secured to the motor shaft by a stainless steel cap screw equipped with a Nylock or other suitable self locking device.
- E. The impeller shall not be screwed or pinned to the motor pump shaft, and shall be readily removable without the use of special tools. To prevent the buildup of stringy materials, grit and other foreign particles around the pump shaft, all impellers less than full diameter shall be trimmed inside the impeller shroud. The shroud shall remain full diameter so that close minimum clearance from shroud to volute is maintained. Both the end of the shaft and bore of the impeller shall be tapered to permit easy removal of the impeller from the shaft. The pump shall have an adapter providing a large water reservoir above the impeller to provide for positive exclusion of air from the impeller. The seal shall be inside this area to assure lubrication. Pumps which do not use hollow priming adapters for positive lubrication of the seal will not be acceptable.
- F. The pump shall be constructed so as to permit priming from the low pressure area behind the impeller. Priming from high pressure connections tending to cause solids to enter and clog the priming system will not be acceptable. The priming bowl shall be transparent to enable the operator to monitor the priming level. The pump shall be arranged so that the rotating element can easily be removed from the volute without disconnecting the electrical wiring or disassembling the motor, impeller, backhead or seal so that any foreign object may be removed from the pump or suction line.
- G. The pump shaft shall be sealed against leakage by a single mechanical seal constructed so as to be automatically drained and primed each time the pump is drained and primed. The seal housing shall be bronze. Water which lubricates the mechanical seal shall be automatically drained from around the seal if the pump loses prime, in order to allow both the pump and seal to be drained, thereby preventing freezing and breakage of the seal during power outages in sub-freezing temperatures. The seal shall be of carbon and ceramic materials with mating surfaces lapped to a flatness of one light band. The rotating ceramic shall be held in mating position with the stationary carbon by a stainless steel spring.
- H. The pump volute shall be furnished with mounting lugs and shall be bolted to the station floor plate, forming a gas-tight seal.

2.08 MOTORS

- A. The pump motors shall be vertical, solid shaft, NEMA P-base, squirrel-cage induction type, suitable for 3 Phase, 60 Cycle, 230 Volt electric current. They shall have Class F insulation suitable for temperatures up to 105 degrees C. Insulation temperature shall, however, be maintained below 80 degrees C. The motors shall have normal starting torque and low starting current, as specified by NEMA Design B characteristics. They shall be open drip-proof design with forced air circulation by integral fan. Openings for ventilation shall be uniformly spaced around the motor frame. Leads shall be terminated in a cast connection box and shall be clearly identified.
- B. The motors shall have a 1.15 service factor. The service factor shall be reserved for the Owner's protection. The motors shall not be overloaded beyond their nameplate rating, at the design conditions, nor at any head in the operating range specified under Operating Conditions.
- C. The motor pump shaft shall be centered, in relation to motor base, within 0.005". The shaft runout shall not exceed 0.003". The motor shaft shall equal or exceed the diameter specified under Main Pumps, at all points from immediately below the top bearing to the top of the impeller hub. A bearing cap shall be provided to hold the bottom motor bearing in a fixed position. Bearing housings shall be provided with fittings for lubrication as well as purging old lubricant.
- D. The motor shall be fitted with heavy lifting eyes, each capable of supporting the entire weight of the pump and motor rotating assembly.

2.09 CONTROLS

- A. The control equipment shall be mounted in a NEMA Type 1 steel enclosure with a removable access cover. The circuit breakers, starter reset buttons and control switches shall be operable without removing the access cover, for deadfront protection.
- B. A grounding type convenience outlet shall be provided on the side of the cabinet for operation of 120 volt AC devices. Thermal magnetic air circuit breakers shall be provided for branch disconnect service and short circuit protection of all motor control and auxiliary circuits.
- C. Magnetic across-the-line starters with under-voltage release and overload coils for each phase shall be provided for each pump motor to give positive protection. All starters shall be NEMA rated – IEC type starters shall not be acceptable. Each single phase auxiliary motor shall be equipped with an over-current protection device in addition to the branch circuit breaker, or shall be impedance protected. All switches shall be labeled and a coded wiring diagram shall be provided.
- D. To control the operation of the pumps with variation of liquid level in the wet well, a Devar Model 332 Controller shall be installed in the control panel by the pump station manufacturer. The liquid level shall be monitored by a submersible hydrostatic pressure transducer with stainless steel sensor diaphragm providing a 4-20 mA signal to the pump controller. The submersible transducer shall be a Blue Ribbon "Bird Cage" unit. Three (3) float displacement switches shall be provided to automatically operate the pumps in back-up mode in the event

the digital control system or the submersible level transducer fails. The back-up system shall be independent of the digital system. A minimum of 30 feet of cord shall be provided with each switch. The cord shall have a corrosion resistant vinyl jacket and shall be multi-stranded in order to prevent fatigue. The displacement switch cords and the cable for the submersible pressure transducer shall enter the wet well through cord grip seals.

- E. An automatic alternator with manual switch shall be provided to change the sequence of operation of the pumps after every cycle. The manual switch shall allow either pump to be selected as a base pump or for automatic operation.
- F. Provisions shall also be made for the pumps to operate in parallel should the level in the wet well continue to rise above the starting level for the low level "Lead" pump.

2.10 ACCESSORIES

- A. An adjustable displacement switch shall be provided to sense a high water level condition. The switch shall hang into the wet well and shall activate a contact to indicate the high water condition.
- B. A vapor-proof light fixture with a 12 V 50 watt lamp, red globe and guard shall be furnished for outdoor mounting to signal the alarm condition.
- C. A running time meter shall be supplied for each pump to show the number of hours of operation. The meter shall be enclosed in a dust and moisture-proof molded plastic case. The flush mounted dial shall register in hours and tenths of hours up to 99999.9 hours before repeating. The meter shall be suitable for operation on 120 VAC supply.
- D. A 2 or 3 KVA insulating type transformer shall be provided to supply power lights, controls and auxiliary devices. A 2 KVA transformer shall be used where the suction pipes are 4" size. A 3 KVA transformer shall be used where the suction pipe sizes are 6" or larger. The transformer shall have 240/460 volt primary, 120/240 volt secondary, Class F insulation, with temperature rise not to exceed 115 degrees C above a 40 degree C ambient. The core and coil shall be protected by a metal housing to prevent damage.
- E. A relay with double pole double throw contacts to monitor and protect against phase loss (single phase), under voltage (brown outs) and phase reversal (improper sequence) shall be provided in the control system. The relay shall activate the high water alarm light in the event of a failure. The relay shall automatically reset whenever three phase service returns to normal.
- F. Adjustable time delay relays shall be provided to prevent simultaneous starting of the pump motors after power failure.
- G. Glycerin filled pressure/vacuum gauges with diaphragm protectors shall be provided for each pump. Each gauge shall be furnished with isolation valve and tubing.

2.11 VACUUM PRIMING SYSTEM

- A. A separate and independent priming system shall be furnished for each pump, providing complete standby operation. Each priming system shall include a separate vacuum pump. Vacuum pumps shall have corrosion resistant internal components. The vacuum priming system shall be complete with large port vacuum control solenoid valves, Sonic Start™ prime level sensor, float operated check valves to protect the vacuum pumps, and all necessary shut-off valves. The float operated check valves shall have a transparent body for visual inspection of the liquid level and shall have an automatic drain check valve. All hoses and tubing used in the priming system shall be at least 3/8" nominal diameter.
- B. The solenoid valves used in the vacuum priming system shall be of the high flow, direct acting brass body type, with threaded ports, NBR seals and 300 Series stainless steel plunger, rod, plate and springs. The minimum orifice diameter shall be 5/16". The solenoid valves shall be UL Listed, with Class F coil rating and suitable voltage and thermal capacity for the application.
- C. Each solenoid valve shall be protected by a vapor filter, installed in the vacuum line between the valve and the priming dome. The vapor filter shall be constructed of corrosion resistant materials and shall have a minimum filtration area of 2.74 square inches and shall be suitable for operation from 25"Hg to 100 PSI. The filter shall be readily replaceable without the use of special tools.
- D. Liquid level in the pump priming chamber shall be monitored by a Sonic Start™ resonant frequency liquid level sensor with piezoelectric drive and sensitive circuits to detect frequency shifts when the sensor is covered by liquid. This type of system shall be used rather than an electrode system or mechanical means such as a float, to avoid electrical or moving parts inside the chamber, which may accumulate debris, short out, bind or fail. Only a resonant frequency level sensor with no electrical components or floats in the priming chamber shall be used.
- E. The priming system shall automatically provide positive lubrication of the mechanical seal each time a main pump is primed. To prevent excessive stoppage due to grease accumulation, no passageway in the priming system through which the pumped liquid must pass shall be smaller than the equivalent of a 2-1/2" opening.
- F. The vacuum priming system shall have two field selectable modes of operation. In the "ON DEMAND" mode, the priming system will operate only after a pump is called on to run, and if it is not primed. Once primed, the pump will be allowed to run. In the "CONSTANT PRIME" mode, both pumps are kept primed continuously, and ready to start immediately when called for.

2.12 ENVIRONMENTAL EQUIPMENT

- A. A ventilating blower capable of delivering 250 CFM at 0.1" static water pressure shall be provided in order to remove the heat generated by continuous motor operation. The ventilating blower shall be turned on and off automatically by the preset thermostat. A heavy extruded aluminum louvered grill with adjustable openings shall cover the discharge of the blower. A similar grill shall be provided in the other end of the station enclosure for air intake.

- B. A 500 watt electric heater controlled by a preset thermostat shall be furnished. The heater shall be rigidly mounted in the station to prevent removal.

2.13 MAIN PIPING

- A. The pump suctions shall be drilled and tapped for a 125 pound American Standard flange for easy connection of the suction risers.
- B. The discharge line from each pump shall be fitted with a clapper-type check valve and eccentric plug valve. Size, location and quantity of check valves and plug valves shall be as shown on the Contract Drawing.
- C. The check valve shall be of the spring-loaded type with external lever arm and an easily replaced resilient seat for added assurance against priming leaks. Check valves shall have stainless steel shaft with replaceable bronze shaft bushings and shall be sealed through the bearings with O-rings. To facilitate back flushing of either pump, only check valves with outside lever arms will be acceptable. Ball-type check valves are specifically unacceptable for this application.
- D. All station piping and fittings shall be capable of passing a 3" solid.
- E. An operating wrench shall be provided for the plug valves.
- F. Protrusions through the floor plate shall be gas-tight where necessary to effect sealing between the equipment chamber and the wet well. Bolted and sealed joints shall be provided at the pump volutes or suction pipes in order to prevent corrosive, noxious fumes from entering the station. The pump station manufacturer shall extend the suction and discharge connections below the floor plate at the factory so that field connections can be made without disturbing the gas-tight seals.
- G. The manufacturer of the pump station shall provide a compression type sleeve coupling for installation in the common discharge pipe. Provisions shall be made for securing the coupling to the station floor plate.

2.14 FLEXIBLE CONDUIT

To prevent potential settling damage, at least four feet of flexible conduit shall be used to connect rigid conduit to the lift station.

2.15 SPARE PARTS

A complete replacement pump shaft seal assembly shall be furnished with each pump station. The spare seal shall be packed in a suitable container and shall include complete installation instructions. A spare volute gasket and seal gasket shall be provided.

PART 3 - EXECUTION

3.01 FACTORY TESTS

- A. All components of the pump station shall be given an operational test at the pump station manufacturer's facility to check for excessive vibration or leaks in the piping or seals, and to correct operation of the automatic control and vacuum priming systems and all auxiliary equipment. Installed pumps shall take suction from a deep wet well, simulating actual service conditions. The control panel shall undergo both a dry logic test and a full operational test with all systems operating.
- B. Factory test instrumentation must include flow measuring with indicator; compound suction gauge; bourdon tube type discharge pressure gauge; electrical meters to measure amperes, volts, kilowatts and power factor; speed indicator; and a vibrometer capable of measuring both amplitude and frequency.

3.02 INSTALLATION AND OPERATING INSTRUCTIONS

- A. Installation of the pump station shall be done in accordance with the written instructions provided by the manufacturer.
- B. The Manufacturer shall supply four (4) copies of Operation and Maintenance manuals which will include parts lists of components and complete service procedures and troubleshooting guide.

3.03 START-UP

The pump station manufacturer shall provide complete start-up service. The pump station manufacturer representative or factory service technician will inspect the completed installation to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally and otherwise acceptable; the station installation is safe and in optimum working condition; and conforms to the specified operating conditions. The start-up technician shall instruct the Owner's personnel in the proper operation and maintenance procedures.

3.04 FINAL INSPECTION

The final inspection will be performed by City personnel in accordance with the "Clarksville Gas & Water Lift Station Final Inspection Checklist" included in [Appendix F](#).

END OF SECTION

WET WELL MOUNTED, SUCTION LIFT SEWAGE PUMP STATIONS WITH SERIES PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Contractor shall furnish and install factory-built, automatic pumping stations with pumps in series as described herein and as manufactured by Smith & Loveless, Inc. Each station shall be complete with all needed equipment factory installed on a welded steel base plate with fiberglass cover as shown on the Contract Drawings.
- B. The principal items of equipment in each station shall include vertical, close-coupled, motor driven, vacuum primed, non-clog sewage pumps; valves; internal piping; central control panel with circuit breakers, motor starters and automatic pumping level controls; heater, ventilating blower, priming pumps and appurtenances, and all internal wiring.

1.02 OPERATING CONDITIONS

- A. Each station shall be equipped with four (4) pumps (two pumps in series) capable of delivering the flows of raw water or wastewater against the total dynamic heads indicated and at the efficiencies specified in the contract documents. Operating design points will be developed for each specific application. Hydraulic calculations will be required to demonstrate the methods used to determine the design points.
- B. All openings and passages shall be large enough to permit the passage of a sphere 3" in diameter and each pump shall have a flanged suction and discharge connection no smaller than 4".
- C. The pump motors shall not be overloaded beyond the nameplate rating at the design conditions nor at any head in the operating range.

1.03 MANUFACTURED EQUIPMENT EVALUATION

- A. The specifications and drawings detail Smith & Loveless equipment and represent the minimum standard of quality for both equipment and materials of construction.
- B. Substitution of other makes may be considered if the equipment proposed for substitution is superior or equal in quality and efficiency to the standards of quality named in the specifications and is demonstrated to the satisfaction of the Owner.
- C. Contractors wishing to substitute equipment shall include the following submittal information with their proposal. This submittal shall include all necessary information for the proper determination of the acceptability of the proposed substitution and shall not necessarily be limited to the following:

1. Complete description of the equipment, system, process or function, including a list of system components and features, drawings, catalog information and cuts, manufacturer's specifications, including materials descriptions.
 2. Performance data and curves, and horsepower requirements.
 3. Outside utility requirements, such as water, power, air, etc.
 4. Functional description of any internal instrumentation and controls supplied including list of parameters monitored, controlled or alarmed.
 5. Addresses and phone numbers of nearest service centers and listing of the manufacturer's or representative's services available at these locations, including addresses and phone numbers of the nearest parts warehouses capable of providing full parts replacement and/or repair services.
 6. A list of five installations in the states where similar equipment by the manufacturer is currently in similar serve; include contact name, telephone number, mailing address of the municipality or installation; engineer, owner, and installing Contractor. If five installations do not exist, the list shall include all that do exist, if any.
 7. Detailed information on site, architectural, structural, mechanical, plumbing, electrical and control, and all other changes or modifications to the design and construction work necessary to adapt the equipment or systems to the arrangement shown and/or functions described on the drawings and in the technical specifications. This shall include plan view and section sketches illustrating any additional space requirements necessary to provide the minimum adequate clear space within and around the equipment for operation and maintenance, as shown on the drawings and specified.
 8. All differences between the specifications and the proposed substitute equipment shall be clearly stated in writing under a heading of "differences".
 9. Other specific submittal requirements listed in the detailed equipment and material specifications.
- D. Approval of the substitution as an alternate shall in no way relieve the Contractor from submitting the specified shop drawings for approval or complying fully with all provisions of the specifications and drawings. If substituted equipment is accepted, the Contractor shall, at his own expense, make any changes in the structures, piping, electrical, etc. necessary to accommodate the equipment. If engineering is required due to substitution of alternate equipment, the Contractor shall pay for all engineering changes. To receive final consideration, copies of the manufacturer's quotations for the equipment may be required to document the savings to the satisfaction of the Engineer. It is the intent that the Owner shall receive the full benefit of the savings in cost of the equipment and the Contractor's bid price shall be reduced by an amount equal to the savings. In all technical and other evaluations, the decision of the Engineer is final.

1.04 WARRANTY

- A. The manufacturer of the pump station shall guarantee the structure and all equipment to be free from defects in materials and workmanship for a period up to one year from the date of start-up, not to exceed 18 months from the date of shipment. Warranties and guarantees of suppliers of various components in lieu of a single source responsibility by the pump station manufacturer will not be accepted. The pump station manufacturer shall be solely responsible for the guarantee of the station and all components.

- B. In the event a component fails to perform as specified or is proven defective in service during the guarantee period, the pump station manufacturer shall provide a replacement part without cost to the Owner. He shall further provide, without cost, such labor as may be required to replace, repair or modify major components such as the steel structure, pumps, pump motors, suction and discharge piping and valve assembly.

PART 2 – PRODUCTS

2.01 STATION

- A. All openings and passages shall be large enough to permit the passage of sphere 3” in diameter. Each station shall be constructed in one complete factory-built assembly. It shall be sized to rest on top of the wet well as detailed in the contract drawings.
- B. The supporting floor plate shall be a minimum 1” thick steel with reinforcing as required to prevent deflection and to insure an absolutely rigid support. Steel plate shall meet or exceed ASTM A-36 specifications.
- C. The pump volutes and discharge piping shall be mounted in relation to the floor plate as detailed in the Contract Drawings. The suction and discharge connections, where they pass the floor plate, shall be sealed by gaskets rather than being welded to allow adjustment and replacement.

2.02 FIBERGLASS COVER

- A. Each pump station shall be enclosed by a hinged fiberglass cover made of molded reinforced orthophthalic polyester resins with a minimum of 30% glass fibers with a minimum average length of 1-1/4”. The outside of the enclosure shall be coated with a polyester protective in-mold coating for superior resistance to weathering, ultraviolet radiation, yellowing and chalking. The completed fiberglass cover shall be resistant to mold, mildew, fungus and corrosive liquids and gasses normally found in pump station environments.
- B. The dimensions of the enclosure shown on the Contract Drawings shall be considered for internal component clearances and accessibility and nothing smaller will be acceptable. The cover shall have a suitable drip-lid around the edge and shall be provided with a hasp and staple connection to the floor plate to allow the pump chamber to be locked with a padlock.
- C. The cover shall be attached with a multi segment stainless steel hinge, constructed of 7 gauge (minimum) type 304 stainless steel with a 3/8” diameter stainless steel pin and supporting at least 75% of the width at one end. Stainless steel bolts with tamperproof

heads and a full width 3/8” thick anodized aluminum backing plate shall anchor the hinge to the fiberglass cover. Dual high pressure gas struts shall be provided to counteract the dead weight of the cover assembly and limit the maximum lifting force required for opening to less than 20 pounds. The cover shall be self-latching upon opening, with a manually operated

release for closing. Duplex heavy gauge safety chains shall be provided to prevent over extension.

- D. All hardware and components of the cover assembly which are exposed to the weather shall be constructed of corrosion resistant materials. Heavy extruded aluminum adjustable louvers shall be provided on each end of the fiberglass cover, which are capable of being closed during cold weather operation.

2.03 LIFTING ARM

To allow on-site maintenance of the pumps, a stanchion with lifting arm shall be provided to lift/pull each pump. The stanchion requirement will apply to both vertical and horizontal pumps, whichever is supplied by the installing Contractor. The arm shall have a hook over the center of the motor to support a hoist for removal of the motors, impellers and pumps from the station.

2.04 MANWAY

- A. An aluminum manway cover fabricated of 1/4" treadplate, located exterior to the fiberglass pump chamber shall be provided, complete with padlocking provisions. The manway shall be an integral part of the pump station floor and shall provide access to the wet well. The minimum open area of the manway access into the wet well shall be at least 4.2 square feet.
- B. The manway cover shall have a three color 7"x10" (minimum) corrosion resistant sign permanently affixed to it, reading "DANGER – Before Entering, Test for Explosive Gasses. Test for Oxygen Deficiency. Supply Fresh Air to Work Area."

2.05 WELDING

All steel structural members shall be joined by electric arc welding with welds of adequate section for the joint involved. Structural welding shall be performed in accordance with AWS standards and procedures.

2.06 CORROSION PROTECTION

After welding, all inside and outside surfaces of the structure shall be blasted with steel grit to remove rust, mill scale, weld slag etc. All weld splatter and surface roughness shall be removed by grinding. Immediately following the cleaning, a single heavy inert coating shall be factory applied to all inside and outside surfaces prior to shipment. This coating shall be Versapox epoxy resin specially formulated for abrasion and corrosion resistance. The dry coating shall contain a minimum of 86% epoxy resin with the balance being pigments and thixotropic agents.

2.07 MAIN PUMPS

- A. The pumps shall be 4" vertical, non-clog type of heavy cast iron construction, especially designed for the use of mechanical seals and vacuum priming. In order to minimize seal wear caused by linear movement of the shaft, the shaft bearing nearest the pump impeller shall be locked in place so that end play is limited to the clearing within the bearing.

- B. To minimize seal wear resulting from shaft deflection caused by the radial thrust of the pump, the shaft from the top of the impeller to the lower bearing supporting the impeller shall have a minimum diameter of 1-7/8" for motor sizes 1.5 H.P. through 15 H.P. (motor frame sizes 213 through 286); 2-1/8" for motor sizes 20 H.P. through 30 H.P. (motor frame sizes 324 and 326); and 3" for motor sizes 40 H.P. and larger (motor frame sizes 364 and larger). The dimension from the lowest bearing to the top of the impeller shall not exceed 6".
- C. The bearing nearest the impeller shall be designed for the combined thrust and radial load. The upper bearing shall be free to move linearly with the thermal expansion of the shaft and shall carry only radial loads. The shaft shall be solid stainless steel through the pump and bottom bearing to eliminate corrosion within the pump or the mechanical seal. Removable shaft sleeves will not be acceptable if the shaft under the sleeve does not meet the specified minimum diameter.
- D. The pump impellers shall be of the enclosed type made of close-grained cast iron and shall be balanced. The impeller shall be keyed with a stainless steel key and secured to the motor shaft by a stainless steel cap screw equipped with a Nylock or other suitable self locking device.
- E. The impeller shall not be screwed or pinned to the motor pump shaft, and shall be readily removable without the use of special tools. To prevent the buildup of stringy materials, grit and other foreign particles around the pump shaft, all impellers less than full diameter shall be trimmed inside the impeller shroud. The shroud shall remain full diameter so that close minimum clearance from shroud to volute is maintained. Both the end of the shaft and bore of the impeller shall be tapered to permit easy removal of the impeller from the shaft. The pump shall have an adapter providing a large water reservoir above the impeller to provide for positive exclusion of air from the impeller. The seal shall be inside this area to assure lubrication. Pumps which do not use hollow priming adapters for positive lubrication of the seal will not be acceptable.
- F. The pump shall be constructed so as to permit priming from the low pressure area behind the impeller. Priming from high pressure connections tending to cause solids to enter and clog the priming system will not be acceptable. The priming bowl shall be transparent to enable the operator to monitor the priming level. The pump shall be arranged so that the rotating element can easily be removed from the volute without disconnecting the electrical wiring or disassembling the motor, impeller, backhead or seal so that any foreign object may be removed from the pump or suction line.
- G. The pump shaft shall be sealed against leakage by a single mechanical seal constructed so as to be automatically drained and primed each time the pump is drained and primed. The seal housing shall be bronze. Water which lubricates the mechanical seal shall be automatically drained from around the seal if the pump loses prime, in order to allow both the pump and seal to be drained, thereby preventing freezing and breakage of the seal during power outages in sub-freezing temperatures. The seal shall be of carbon and ceramic materials with mating surfaces lapped to a flatness of one light band. The rotating ceramic shall be held in mating position with the stationary carbon by a stainless steel spring.
- H. The pump volute shall be furnished with mounting lugs and shall be bolted to the station floor plate, forming a gas-tight seal.

2.08 MOTORS

- A. The pump motors shall be vertical, solid shaft, NEMA P-base, squirrel-cage induction type, suitable for 3 Phase, 60 Cycle, 230 Volt electric current. They shall have Class F insulation suitable for temperatures up to 105 degrees C. Insulation temperature shall, however, be maintained below 80 degrees C. The motors shall have normal starting torque and low starting current, as specified by NEMA Design B characteristics. They shall be open drip-proof design with forced air circulation by integral fan. Openings for ventilation shall be uniformly spaced around the motor frame. Leads shall be terminated in a cast connection box and shall be clearly identified.
- B. The motors shall have a 1.15 service factor. The service factor shall be reserved for the Owner's protection. The motors shall not be overloaded beyond their nameplate rating, at the design conditions, nor at any head in the operating range specified under Operating Conditions.
- C. The motor pump shaft shall be centered, in relation to motor base, within 0.005". The shaft runout shall not exceed 0.003". The motor shaft shall equal or exceed the diameter specified under Main Pumps, at all points from immediately below the top bearing to the top of the impeller hub. A bearing cap shall be provided to hold the bottom motor bearing in a fixed position. Bearing housings shall be provided with fittings for lubrication as well as purging old lubricant.
- D. The motor shall be fitted with heavy lifting eyes, each capable of supporting the entire weight of the pump and motor rotating assembly.

2.09 CONTROLS

- A. The control equipment shall be mounted in a NEMA Type 1 steel enclosure with a removable access cover. The circuit breakers, starter reset buttons and control switches shall be operable without removing the access cover, for deadfront protection.
- B. A grounding type convenience outlet shall be provided on the side of the cabinet for operation of 120 volt AC devices. Thermal magnetic air circuit breakers shall be provided for branch disconnect service and short circuit protection of all motor control and auxiliary circuits.
- C. Magnetic across-the-line starters with under-voltage release and overload coils for each phase shall be provided for each pump motor to give positive protection. All starters shall be NEMA rated – IEC type starters shall not be acceptable. Each single phase auxiliary motor shall be equipped with an over-current protection device in addition to the branch circuit breaker, or shall be impedance protected. All switches shall be labeled and a coded wiring diagram shall be provided.
- D. To control the operation of the pumps with variation of liquid level in the wet well, a Devar Model 332 Controller shall be installed in the control panel by the pump station manufacturer. The liquid level shall be monitored by a submersible hydrostatic pressure transducer with stainless steel sensor diaphragm providing a 4-20 mA signal to the pump controller. The submersible transducer shall be a Blue Ribbon "Bird Cage" unit. Three (3) float displacement switches shall be provided to automatically operate the pumps in back-up mode in the event

the digital control system or the submersible level transducer fails. The back-up system shall be independent of the digital system. A minimum of 30 feet of cord shall be provided with each switch. The cord shall have a corrosion resistant vinyl jacket and shall be multi-stranded in order to prevent fatigue. The displacement switch cords and the cable for the submersible pressure transducer shall enter the wet well through cord grip seals.

- E. An automatic alternator with manual switch shall be provided to change the sequence of operation of the pumps after every cycle. The manual switch shall allow either pump to be selected as a base pump or for automatic operation.
- F. Provisions shall also be made for the pumps to operate in parallel should the level in the wet well continue to rise above the starting level for the low level "Lead" pump.
- G. A time delay relay shall be provided to cause the second stage pump in each pump set to start and come up to speed before the lower stage pump in the set is started in order to prevent starting of a pump with pressure on the seal.

2.10 VACUUM PRIMING SYSTEM

- A. A separate and independent priming system shall be furnished for each pump, providing complete standby operation. Each priming system shall include a separate vacuum pump. Vacuum pumps shall have corrosion resistant internal components. The vacuum priming system shall be complete with large port vacuum control solenoid valves, Sonic Start™ prime level sensor, float operated check valves to protect the vacuum pumps, and all necessary shut-off valves. The float operated check valves shall have a transparent body for visual inspection of the liquid level and shall have an automatic drain check valve. All hoses and tubing used in the priming system shall be at least 3/8" nominal diameter.
- B. The solenoid valves used in the vacuum priming system shall be of the high flow, direct acting brass body type, with threaded ports, NBR seals and 300 Series stainless steel plunger, rod, plate and springs. The minimum orifice diameter shall be 5/16". The solenoid valves shall be UL Listed, with Class F coil rating and suitable voltage and thermal capacity for the application.
- C. Each solenoid valve shall be protected by a vapor filter, installed in the vacuum line between the valve and the priming dome. The vapor filter shall be constructed of corrosion resistant materials and shall have a minimum filtration area of 2.74 square inches and shall be suitable for operation from 25"Hg to 100 PSI. The filter shall be readily replaceable without the use of special tools.
- D. Liquid level in the pump priming chamber shall be monitored by a Sonic Start™ resonant frequency liquid level sensor with piezoelectric drive and sensitive circuits to detect frequency shifts when the sensor is covered by liquid. This type of system shall be used rather than an electrode system or mechanical means such as a float, to avoid electrical or moving parts inside the chamber, which may accumulate debris, short out, bind or fail. Only a resonant frequency level sensor with no electrical components or floats in the priming chamber shall be used.

- E. The priming system shall automatically provide positive lubrication of the mechanical seal each time a main pump is primed. To prevent excessive stoppage due to grease accumulation, no passageway in the priming system through which the pumped liquid must pass shall be smaller than the equivalent of a 2-1/2" opening.
- F. The vacuum priming system shall have two field selectable modes of operation. In the "ON DEMAND" mode, the priming system will operate only after a pump is called on to run, and if it is not primed. Once primed, the pump will be allowed to run. In the "CONSTANT PRIME" mode, both pumps are kept primed continuously, and ready to start immediately when called for.

2.11 PUMP STATION ACCESSORIES

- A. An adjustable displacement switch shall be provided to sense a high water level condition. The switch shall hang into the wet well and shall activate a contact to indicate the high water condition.
- B. A vapor-proof light fixture with a 12 V 50 watt lamp, red globe and guard shall be furnished for outdoor mounting to signal the alarm condition.
- C. A running time meter shall be supplied for each pump to show the number of hours of operation. The meter shall be enclosed in a dust and moisture-proof molded plastic case. The flush mounted dial shall register in hours and tenths of hours up to 99999.9 hours before repeating. The meter shall be suitable for operation on 120 VAC supply.
- D. A 2 or 3 KVA insulating type transformer shall be provided to supply power lights, controls and auxiliary devices. A 2 KVA transformer shall be used where the suction pipes are 4" size. A 3 KVA transformer shall be used where the suction pipe sizes are 6" or larger. The transformer shall have 240/460 volt primary, 120/240 volt secondary, Class F insulation, with temperature rise not to exceed 115 degrees C above a 40 degree C ambient. The core and coil shall be protected by a metal housing to prevent damage.
- E. A relay with double pole double throw contacts to monitor and protect against phase loss (single phase), under voltage (brown outs) and phase reversal (improper sequence) shall be provided in the control system. The relay shall activate the high water alarm light in the event of a failure. The relay shall automatically reset whenever three phase service returns to normal.
- F. Adjustable time delay relays shall be provided to prevent simultaneous starting of the pump motors after power failure.
- G. Glycerin filled pressure/vacuum gauges with diaphragm protectors shall be provided for each pump. Each gauge shall be furnished with isolation valve and tubing.

2.12 ENVIRONMENTAL EQUIPMENT

- A. A ventilating blower capable of delivering 250 CFM at 0.1" static water pressure shall be provided in order to remove the heat generated by continuous motor operation. The

ventilating blower shall be turned on and off automatically by the preset thermostat. A heavy extruded aluminum louvered grill with adjustable openings shall cover the discharge of the blower. A similar grill shall be provided in the other end of the station enclosure for air intake.

- B. A 500 watt electric heater controlled by a preset thermostat shall be furnished. The heater shall be rigidly mounted in the station to prevent removal.

2.13 MAIN PIPING

- A. The pump suction shall be drilled and tapped for a 125 pound American Standard flange for easy connection of the suction risers.
- B. The discharge line from each pump shall be fitted with a clapper-type check valve and eccentric plug valve. Size, location and quantity of check valves and plug valves shall be as shown on the Contract Drawing.
- C. The check valve shall be of the spring-loaded type with external lever arm and an easily replaced resilient seat for added assurance against priming leaks. Check valves shall have stainless steel shaft with replaceable bronze shaft bushings and shall be sealed through the bearings with O-rings. To facilitate back flushing of either pump, only check valves with outside lever arms will be acceptable. Ball-type check valves are specifically unacceptable for this application.
- D. All station piping and fittings shall be capable of passing a 3" solid.
- E. An operating wrench shall be provided for the plug valves.
- F. Protrusions through the floor plate shall be gas-tight where necessary to effect sealing between the equipment chamber and the wet well. Bolted and sealed joints shall be provided at the pump volutes or suction pipes in order to prevent corrosive, noxious fumes from entering the station. The pump station manufacturer shall extend the suction and discharge connections below the floor plate at the factory so that field connections can be made without disturbing the gas-tight seals.
- G. The manufacturer of the pump station shall provide a compression type sleeve coupling for installation in the common discharge pipe. Provisions shall be made for securing the coupling to the station floor plate.

2.14 FLEXIBLE CONDUIT

To prevent potential settling damage, at least four feet of flexible conduit shall be used to connect rigid conduit to the lift station.

2.15 SPARE PARTS

A complete replacement pump shaft seal assembly shall be furnished with each pump station. The spare seal shall be packed in a suitable container and shall include complete installation instructions. A spare volute gasket and seal gasket shall be provided.

PART 3 – EXECUTION

3.01 FACTORY TESTS

- A. All components of the pump station shall be given an operational test at the pump station manufacturer's facility to check for excessive vibration or leaks in the piping or seals, and to correct operation of the automatic control and vacuum priming systems and all auxiliary equipment. Installed pumps shall take suction from a deep wet well, simulating actual service conditions. The control panel shall undergo both a dry logic test and full operational tests with all systems operating.
- B. Factory test instrumentation must include flow measuring with indicator; compound suction gauge; bourdon tube type discharge pressure gauge; electrical meters to measure amperes, volts, kilowatts and power factor; speed indicator; and a vibrometer capable of measuring both amplitude and frequency.

3.02 INSTALLATION AND OPERATING INSTRUCTIONS

- A. Installation of the pump station shall be done in accordance with the written instructions provided by the manufacturer.
- B. Four (4) operation and maintenance manuals shall be furnished with each pump station which will include parts lists of components and complete service procedures, and a troubleshooting guide.

3.03 START-UP

The pump station manufacturer shall provide complete start-up service. The pump station manufacturer representative or factory service technician will inspect the completed installation to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally and otherwise acceptable; the station installation is safe and in optimum working condition; and conforms to the specified operating conditions. The start-up technician shall instruct the Owner's personnel in the proper operation and maintenance procedures.

3.04 FINAL INSPECTION

The final inspection will be performed by City personnel in accordance with the "Clarksville Gas & Water Lift Station Final Inspection Checklist" included in [Appendix F](#).

END OF SECTION

LOW PRESSURE GRINDER PUMP STATIONS

PART 1 - GENERAL

1.01 GENERAL DESCRIPTION

- A. The manufacturer shall furnish complete Grinder Pump Station(s), consisting of a grinder pump, a tank constructed of high density polyethylene, NEMA 6P electrical quick disconnect, pump removal system, discharge piping assembly with shut-off valve, anti-siphon valve, check valve, electrical alarm panel, and all necessary internal wiring and controls. For ease of serviceability, all pump motor/grinder units shall be of like type and horsepower throughout the system.
- B. Prior to design of a low pressure sewer system, discussion shall be undertaken with the City Engineer to determine the applicability of this type of system.
- C. The City Engineer at his discretion shall request that the Developer/Builder utilize a low pressure system (LPS) in whole or in part when this approach would best fit the requirements of the Clarksville Gas & Water Department, eliminate the need for one or more sewer lift stations and best satisfy the needs of customers. The application of LPS will be used to supplement the existing gravity sewer systems in areas where gravity conveyance sewers cannot properly and efficiently meet customer needs, including but not limited to the following situations:
1. Portions of subdivisions where terrain features preclude gravity sewers.
 2. Locations where unique circumstances dictate LPS.
- The use of the LPS approach will not be allowed in lieu of off-site gravity sewer needed to serve a larger sewershed/drainage basin.
- D. Where LPS is approved, the Developer shall bear the entire cost of the system including the hydraulic model of the affected area. The Developer and/or Builder must provide the electrical connection for the grinder pump and the electrical installation must be inspected and approved by the State electrical inspector. Each pump installation must be run in the presence of an inspector from the Clarksville Gas & Water Department to demonstrate proper performance prior to final acceptance.
- E. Where a property owner wishes to connect a private grinder pump(s) to existing gravity system or force main adjacent to the property, the property owner shall install the pump at his own expense subject to obtaining all required permits and inspections. The property owner is responsible for the electrical connection, all excavations, provision and installation of tap material, backfilling and payment of applicable connection fees per Clarksville Code. In addition, if the pump discharges into an existing force main, the City Engineer may request that a hydraulic analysis be performed to assure proper performance. The tap shall be made by the City provided the main has been accepted by the City for operation and maintenance.

- F. After inspection, testing and approval by all parties of the new service installation, the property owner shall bear the responsibility for operation, maintenance and replacement (including grinder pump assembly) up to the point of connection to the City's main.
- G. Connection fees shall be charged as per the Clarksville Code.

1.02 SHOP DRAWINGS

After receipt of notice to proceed, the manufacturer shall furnish a minimum of six (6) sets of shop drawings detailing the equipment to be furnished including dimensional data and materials of construction. The Engineer shall promptly review this data, and return two (2) copies as accepted, or with requested modifications. Upon the Engineer's acceptance of the shop drawings and the manufacturer's receipt of notice to proceed, the manufacturer shall begin fabrication of the equipment.

1.03 MANUFACTURER

- A. Grinder pump stations, complete with all appurtenances, form an integral system, and as such, shall be supplied by one grinder pump station manufacturer. The Contractor shall be responsible for the satisfactory operation of the entire system. The equipment specified shall be a product of a company experienced in the design and manufacture of grinder pumps for specific use in low pressure sewage systems. The company shall submit detailed installation and user instructions for its product, submit evidence of an established service program including complete parts and service manuals, and be responsible for maintaining a continuing inventory of grinder pump replacement parts. The manufacturer shall provide a reference and contact list from ten of its largest contiguous grinder pump installations of the type of grinder pumps described within this specification.
- B. The manufacturer of the grinder pump station shall be Environment One Corporation, or approved equal.
- C. The specifications contained herein are patterned around pumps manufactured by Environmental One Corporation. Products manufactured by Environmental One Corporation shall set the minimum standard of quality. Some modifications to the specifications have been made to allow other manufacturers to be considered, provided their equipment is judged equal by the Owner and they are listed as approved in the original Contract Documents or by Addendum.

1.04 OPERATING CONDITIONS

The pump(s) shall be capable of delivering 15 GPM against a total dynamic head of 0 feet (0 PSIG) and 9 GPM against a total dynamic head of 138 feet (60 PSIG) at a maximum of 8.0 amps. The pump(s) must also be capable of operating at negative total dynamic head without overloading the motor(s). Under no conditions shall in-line piping or valving be allowed to create a false apparent head.

1.05 WARRANTY

The grinder pump manufacturer shall provide a part(s) and labor warranty on the complete station, accessories and control panel for a period of twelve (12) months from the date of acceptance. Any manufacturing defects found during the warranty period will be reported to the manufacturer by the City.

1.06 WARRANTY PERFORMANCE CERTIFICATION

As a pre-construction requirement, the Contractor shall provide a Warranty Performance Certification statement executed by the most senior executive officer of the grinder pump manufacturer, which certifies a minimum of a twelve (12) month warranty. They must further detail any exclusions from the warranty or additional cost items required to maintain the equipment in warrantable condition, including all associated labor and shipping fees, and certify that the manufacturer will bear all costs to correct any original equipment deficiency for the effective period of the warranty. All preventive maintenance requirements shall be included in this form as exclusions. These requirements include, but are not limited to, un-jamming of grinder mechanism, unplugging of lines, periodic motor maintenance, and periodic cleaning of liquid level controls.

PART 2 - PRODUCTS

2.01 PUMP

- A. The pump shall be a custom designed, integral, vertical rotor, motor driven, solids handling pump of the progressing cavity type with a single mechanical seal. The rotor shall be constructed of stainless steel. Plating on the rotor will not be acceptable due to its tendency to delaminate. The stator shall be of a specifically compounded ethylene propylene synthetic elastomer. The material shall be suitable for domestic wastewater service. Its physical properties shall include high tear and abrasion resistance, grease resistance, water and detergent resistance, temperature stability, excellent aging properties, and outstanding wear resistance. Buna-N is not acceptable as a stator material because it does not exhibit the properties as outlined above and as required for wastewater service.
- B. Requirements for grinder pump (LPS) installation:
1. Proposed tank location should be no more than 25 feet from control panel unless permitted otherwise by the City.
 2. Service line valves/valve box is to be placed within property line, near right of way.
 3. Minimum amount of bends in all service line installations.
 4. House connection to tank subject to approval by the City of Clarksville Building and Codes Department.
 5. Service line and tank installation must be inspected by the City of Clarksville Gas & Water Department.
 6. The tank shall be located to preclude entry of surface water through the lid of the tank under all circumstances. The grade must slope away from the station. Covering or burying the top of the station is prohibited.

2.02 GRINDER

The grinder shall be placed immediately below the pumping elements and shall be direct-driven by a single, one-piece, stainless steel motor shaft. The grinder impeller assembly shall be securely fastened to the pump motor shaft. The grinder will be of the rotating type with a stamped, stainless steel shredder ring assembly spaced in accurate, close annular alignment with the driven impeller assembly, which shall carry two hardened, 400 series stainless steel cutter bars. This assembly shall be dynamically balanced and shall operate without vibration over the entire range of specified operating pressures. The grinder shall be constructed so as to eliminate clogging and jamming under all normal operating conditions including pump starting. Sufficient vortex action shall be created to scour the tank free of deposits or sludge banks which would impair the operation of the pump. These requirements shall be accomplished by the following, in conjunction with the pump:

- A. The grinder shall be positioned in such a way that solids are fed in an upward flow direction.
- B. The maximum flow rate through the cutting mechanism must not exceed 4 feet per second. This is a critical design element to prevent jamming and as such must be adhered to.
- C. The inlet shroud shall have a diameter of no less than 5 inches. Inlet shrouds that are less than 5 inches in diameter will not be accepted due to their inability to maintain the specified 4 feet per second maximum inlet velocity which by design prevents unnecessary jamming of the cutter mechanism and eliminates blinding of the pump by large objects blocking the inlet shroud.
- D. The impeller mechanism must rotate at a nominal speed of no greater than 1800 rpm.
- E. The grinder shall be capable of reducing all components in normal domestic sewage, including a reasonable amount of "foreign objects," such as paper, wood, plastic, glass, rubber and the like, to finely divided particles that will pass freely through the passages of the pump and the 1-1/4" diameter discharge piping.

2.03 ELECTRIC MOTOR

As a maximum, the motor shall be a 1 HP, 1725 RPM, 240 Volt 60 Hertz, 1 Phase, capacitor start, ball bearing, air-cooled induction type with a low starting current not to exceed 30 amperes and high starting torque of 8.4 foot pounds. Inherent protection against running overloads or locked rotor conditions for the pump motor shall be provided by the use of an automatic-reset, integral thermal overload protector incorporated into the motor. This motor protector combination shall have been specifically investigated and listed by Underwriters Laboratories, Inc., for the application. Non-capacitor start motors or permanent split capacitor motors will not be accepted because of their reduced starting torque and consequent diminished grinding capability. To reduce the potential of environmental concerns, the expense of handling and disposing of oil, and the associated maintenance costs, oil-filled motors will not be accepted.

2.04 MECHANICAL SEAL

The pump shall be provided with a mechanical shaft seal to prevent leakage between the motor and pump. The seal shall have a stationary ceramic seat and carbon rotating surface with faces precision lapped and held in position by a stainless steel spring.

2.05 TANK AND INTEGRAL ACCESSWAY

- A. **Simplex Unit:**
The tank shall be made of high density polyethylene, with a melt index of 2.0 grams/10 minutes or lower to assure high environmental stress cracking resistance. Corrugated sections are to be made of a double wall construction with the internal wall being generally smooth to promote scouring. Corrugations of the outside wall are to be of a minimum amplitude of 1-½" to provide necessary transverse stiffness. Any incidental sections of a single wall construction are to be a minimum 0.250 inch thick. All seams created during tank construction are to be thermally welded and factory tested for leak tightness. Tank wall and bottom must withstand the pressure exerted by saturated soil loading at maximum burial depth. All station components must function normally when exposed to 150 percent of the maximum external soil and hydrostatic pressure.
- B. **Duplex Unit:**
The tank shall be made of rotationally molded high density polyethylene, with a melt index of 2.0 grams/10 minutes or lower to assure high environmental stress cracking resistance. The tank shall have a nominal thickness of ½". All seams created during tank construction are to be thermally welded and factory tested for leak tightness. Tank wall and bottom must withstand the pressure exerted by saturated soil loading at maximum burial depth. All station components must function normally when exposed to 150 percent of the maximum external soil and hydrostatic pressure.
- C. The tank shall be furnished with one EPDM grommet fitting to accept a 4.50" OD DWV or Schedule 40 pipe. Tank capacities shall be as shown on the Contract Drawings.
- D. The accessway shall be an integral extension of the wet well assembly and include a lockable cover assembly providing low profile mounting and watertight capability. Accessway design and construction shall enable field adjustment of the station height by adding either 2-inch or 4-inch vertical extensions without the use of any adhesives or sealants requiring cure time before installation can be completed.
- E. The station shall have all necessary penetrations molded in and factory sealed. To ensure a leak free installation no field penetrations shall be acceptable.
- F. All discharge piping shall be constructed of 304 Series Stainless Steel and terminate outside the accessway bulkhead with a stainless steel, 1-¼ inch female NPT fitting. The discharge piping shall include a stainless steel ball valve rated for 200 psi WOG; PVC ball valves will not be accepted. The bulkhead penetration shall be factory installed and warranted by the manufacturer to be watertight.
- G. The accessway shall include a single NEMA 6P electrical quick disconnect (EQD) for all power and control functions, factory installed with accessway penetrations warranted by the manufacturer to be watertight. Plug-type connections of the power cable onto the pump housing will not be acceptable due to the potential for leaks and electrical shorts. The accessway shall also include a 2-inch PVC vent to prevent sewage gases from accumulating in the tank.

2.06 CHECK VALVE

- A. The pump discharge shall be equipped with a factory installed, gravity operated, flapper-type integral check valve built into the stainless steel discharge piping. The check valve will provide a full-ported passageway when open, and shall introduce a friction loss of less than 6 inches of water at maximum rated flow. Moving parts will be made of a 300 series stainless steel and fabric reinforced synthetic elastomer to ensure corrosion resistance, dimensional stability, and fatigue strength. A nonmetallic hinge shall be an integral part of the flapper assembly providing a maximum degree of freedom to assure seating even at a very low back-pressure. The valve body shall be an injection molded part made of glass filled PVC. Ball type check valves are unacceptable due to their limited sealing capacity in slurry applications.
- B. Each grinder pump installation shall also include one separate check valve of the type detailed above for installation in the 1-1/4" service lateral between the grinder pump station and the sewer main, preferably next to the curb stop.

2.07 ANTI-SIPHON VALVE

- A. The pump discharge shall be equipped with a factory-installed, gravity operated, flapper-type integral anti-siphon valve built into the stainless steel discharge piping.
- B. Moving parts will be made of 300 series stainless steel and fabric-reinforced synthetic elastomer to ensure corrosion resistance, dimensional stability, and fatigue strength. A nonmetallic hinge shall be an integral part of the flapper assembly, providing a maximum degree of freedom to ensure proper operation even at a very low pressure. The valve body shall be injection-molded from a glass-filled thermoplastic resin. Holes or ports in the discharge piping are not acceptable anti-siphon devices, due to their tendency to clog from the solids in the slurry being pumped.

2.08 CORE UNIT

The Grinder Pump Station shall have an easily removable core assembly consisting of the pump, motor, grinder, all motor controls, check valve, anti-siphon valve, EQD and wiring. The watertight integrity of the core unit shall be established by 100 percent factory test at a minimum of 5 PSIG.

2.09 CONTROLS

- A. All necessary controls, including motor and level controls, shall be located in the top housing of the core unit. The top housing will be attached with stainless steel fasteners. Non-fouling wastewater level controls for controlling pump operation shall be accomplished by monitoring the pressure changes in an integral air column connected to a pressure switch. The level detection device shall have no moving parts in direct contact with the wastewater. High-level sensing will be accomplished in the manner detailed above by a separate air-bell sensor and pressure switch of the same type. Closure of the high-level sensing device will energize an alarm circuit as well as a redundant pump-on circuit. For increased reliability, pump ON/OFF and High Level Alarm functions shall not be controlled by the same switch. Float switches of any kind, including float trees, will not be accepted due to the periodic need to maintain (rinsing, cleaning) such devices.

- B. To assure reliable operation of the differential pressure switches each core shall be equipped with a pressure equalization chamber. The equalization chamber shall continuously calibrate the level sensing pressure switches to fluctuations in barometric pressure and prevent fluid from entering the control compartment during high water level conditions. The equalization chamber shall be constructed from EPDM, High Impact Polystyrene and stainless steel and measure 12" in diameter by 6" high. The chamber shall be assembled by the core manufacturer and factory tested at the point of assembly to verify proper operation. The grinder pump will be furnished with a 6 conductor, 14 gauge, type SJOW cable, pre-wired and watertight to meet UL requirements with a FACTORY INSTALLED NEMA 6P EQD half attached to it.

2.10 ALARM PANEL

- A. Each Grinder Pump Station shall include a NEMA 4X, Alarm Panel suitable for wall or pole mounting. The NEMA 4X enclosure shall be manufactured of corrosion resistant thermoplastic and be furnished with a hinged cover and padlock.
- B. For each core, the panel shall contain one (1) - 15 amp, double pole circuit breaker for the power circuit and one (1) 15 amp single pole circuit breaker for the alarm circuit. The Alarm Panel shall include an audio and visual alarm, push-to-run switch, and high level (redundant) pump starting control. The visual alarm lamp shall be inside a red fluted lens mounted to the top of the enclosure in such a manner as to maintain NEMA 4X rating. For duplex units, in addition to the above, two high level indicator lights shall be mounted behind the access cover.
 - 1. When liquid level in the sewage wet well rises above the alarm level, visual and audio alarms will be activated. The contacts on the alarm pressure switch will close. The redundant pump starting system will be energized.
 - 2. The audio alarm may be silenced by means of the externally mounted, push-to-silence button.
 - 3. Visual alarm remains illuminated until the sewage level in the wet well drops below the "off" setting of the alarm pressure switch.
- C. The control panel shall be equipped with an outside quick disconnect to facilitate usage of a generator during a power outage.

2.11 SERVICEABILITY

The grinder pump core unit shall be furnished with polypropylene lifting harness connected to the pump body to facilitate easy removal when necessary. All mechanical and electrical connections must provide easy disconnect accessibility for core unit removal and installation. All motor control components shall be mounted on a readily replaceable bracket for ease of field service.

2.12 SAFETY

The Grinder Pump Station shall be free from objectionable noise, odor, or health hazards, in its capability to perform as specified in either individual or low pressure sewer system applications.

PART 3 - EXECUTION

3.01 FACTORY TEST

Each grinder pump shall be submerged and operated for 5 minutes (minimum). Included in this procedure will be the testing of all ancillary components such as the anti-siphon valve, check valve, level sensors and each unit's dedicated controls. All factory tests shall incorporate each of the above listed items. Certified test results shall be available upon request showing the operation of each grinder pump at two (2) different points on its curve, with the maximum discharge pressure no less than 60 psi. The Engineer reserves the right to inspect such testing procedures with representatives of the City, at the grinder pump manufacturer's facility.

3.02 INSTALLATION

- A. Earth excavation and backfill are specified under Sections 02210 and 02221, but are also to be done as a part of the work under this section, including any necessary sheeting and bracing. The Contractor shall be responsible for handling ground water to provide a firm, dry subgrade for the structure, and shall guard against flotation or other damage resulting from general water or flooding.
- B. The Grinder Pump Stations shall not be set into the excavation until the installation procedures and excavation have been approved by the Engineer.
- C. Remove packing material. Users instructions MUST be given to the City. Hardware supplied with the unit, if required, will be used at installation. The basin will be supplied with a standard 4" inlet grommet (4.50" OD) for connecting the incoming sewer line. Appropriate inlet piping must be used. The basin may not be dropped, rolled or laid on its side for any reason. Installation shall be accomplished so that 1" to 4" of accessway, below the bottom of the lid, extends above the finished grade line. The finished grade shall slope away from the unit. The diameter of the excavated hole must be large enough to allow for the concrete anchor. A 6-inch (minimum) layer of naturally rounded aggregate, clean and free flowing, with particle size of not less than 1/8" or more than 3/4" shall be used as bedding material under each unit. A concrete anti-flotation collar, as detailed on the drawings, and sized according to the manufacturer's instructions, shall be required and shall be pre-cast to the grinder pump or poured in place. Each Grinder Pump Station with its pre-cast anti-flotation collar shall have a minimum of three (3) lifting eyes for loading and unloading purposes. If the concrete is poured in place, the unit shall be leveled and filled with water, to the bottom of the inlet, to help prevent the unit from shifting while the concrete is being poured. The concrete must be manually vibrated to ensure there are no voids. If it is necessary to pour the concrete to a level higher than the inlet piping, an 8" sleeve is required over the inlet prior to the concrete being poured. The Contractor will provide and install a 4-foot piece of 4-inch SCH 40 PVC pipe with watertight cap, to stub-out the inlet for the property owners' installation Contractor, as depicted on the Contract Drawings.
- D. When the grinder pump is being installed at the property with an existing septic tank, the Contractor shall install two (2) knife valves at the point of intercepting the 4-inch diameter service line between the building and the septic tank. The existing septic tank shall remain in an operable condition in case of pump failure. Valve leading to pump shall be tagged accordingly (open/closed).

- E. The electrical enclosure shall be furnished, installed and wired to the Grinder Pump Station by the Contractor. An alarm device is required on every installation; there shall be NO EXCEPTIONS. It will be the responsibility of the Contractor to coordinate with the individual property owner(s) to determine the optimum location for the Alarm Panel. The Contractor shall mount the alarm device in a conspicuous location, as per national and local codes. The Alarm Panel will be connected to the Grinder Pump Station by a length of six (6) conductor 12 gauge type TC cable, in conduit where exposed. The power and alarm circuits must be on separate power circuits. The grinder pump stations will be provided with a minimum of 32 feet of electrical supply cable (25 feet of useable electrical supply cable outside the station) to connect to the alarm panel. This cable shall be supplied with a factory installed EQD half to connect to the mating EQD half on the core.
- F. Minimum electrical wiring requirements:
All LPS electrical systems are to be single phase, 240V AC, 30A, four-wire weatherproof disconnect service. The external NEMA 3 electrical disconnect, installed within five feet (5') of the present location of the sewer line leaving the house to the septic tank, can be fused, non fused or breaker type. The height of the disconnect shall be a minimum of four feet (4') from the grade. The wiring from the main breaker to the disconnect shall be four-wire (two hot, one insulated neutral and one ground wire). The installation of these conductors shall be in conduit where exposed. The permit can be obtained at the Clarksville Department of Electricity, 2001 Wilma Rudolph Boulevard. All work shall be inspected by the State Electrical Inspector.

3.03 BACKFILL REQUIREMENTS

- A. Proper backfill is essential to the long-term reliability of any underground structure. Several methods of backfill are available to produce favorable results with different native soil conditions. The most highly recommended method of backfilling is to surround the unit to grade using Class I or Class II backfill material as defined in ASTM 2321. Class 1A and Class 1B are recommended where frost heave is a concern, Class 1B is a better choice when the native soil is sand or if a high, fluctuating water table is expected. Class 1, angular crushed stone offers an added benefit in that it does not need to be compacted.
- B. Class II, naturally rounded stone, may require more compactive effort, or tamping, to achieve the proper density. If the native soil condition consists of clean compactible soil, with less than 12 percent fines, free of ice, rocks, roots and organic material, it may be an acceptable backfill. Soil must be compacted in lifts not to exceed one foot to reach a final Proctor Density of between 85 percent and 90 percent. Heavy, non-compactible clays and silts are not suitable backfill for this or any underground structure such as inlet or discharge lines.
- C. Another option is the use of a flowable fill (i.e., low slump concrete). This is acceptable when installing grinder pump stations in augured holes where tight clearances make it difficult to assure proper backfilling and compaction with dry materials. Flowable fills should not be dropped more than four feet from the discharge to the bottom of the hole to avoid separation of the constituent materials.

- D. Backfill of clean native earth, free of rocks, roots, and foreign objects shall be thoroughly compacted in lifts not exceeding 12" to a final Proctor Density of not less than 85 percent. Improper backfilling may result in damaged accessways. The grinder pump station shall be installed at a minimum depth of 30 inches below finished grade to the top of the 1-1/4" discharge line to assure frost protection. The finish grade line shall be 1" to 4" below the bottom of the lid; final grade shall slope away from the grinder pump station.
- E. All restoration will be the responsibility of the Contractor. The properties shall be restored to their original condition in all respects, including, but not limited to, curb and sidewalk replacement, landscaping, loaming and seeding, and restoration of the traveled ways, as directed by the Engineer.

3.04 START-UP AND FIELD TESTING

- A. The manufacturer shall provide the services of qualified factory-trained technician(s) who shall inspect the placement and wiring of each station, perform field tests as specified herein, and instruct the City's personnel in the operation and maintenance of the equipment before the stations are accepted by the City. All equipment and materials necessary to perform testing shall be the responsibility of the installing Contractor. This will include, as a minimum, a portable generator (if temporary power is required) and water in each basin. The services of a trained factory-authorized technician shall be provided at a rate of one (1) four (4) day week for each 100 grinder pump stations supplied. Each day shall be ten (10) person hours in duration.
- B. Upon completion of the installation, the authorized factory technicians will perform the following test on each station:
 - 1. Make certain the discharge shut-off valve is fully open. This valve must not be closed when the pump is operating. In some installations, there may be a valve(s) at the street main that must also be open.
 - 2. Turn ON the alarm power circuit.
 - 3. Fill the tank with water to a depth sufficient to verify the high level alarm is operating. Shut off water.
 - 4. Close the pump power circuit breaker. The pump should immediately turn ON. Within one (1) minute the alarm light will turn OFF. Within three (3) minutes the pump will turn OFF.
- C. Upon completion of the start-up and testing, the manufacturer shall submit to the Owner the start-up authorization form describing the results of the tests performed for each Grinder Pump Station. Final acceptance of the system will not occur until authorization forms have been received for each pump station installed and all installation deficiencies have been corrected.

3.05 OPERATION AND MAINTENANCE

The manufacturer shall supply two (2) copies of Operation and Maintenance Manuals to the Owner.

END OF SECTION

SEWAGE SYSTEM FIELD INSTRUMENTATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. In-Line Flow Meters.
- B. Strap-On Flow Meters.
- C. Telemetry (Large Stations).
- D. Wide Area Wireless Telemetry (Small Stations).

1.02 REFERENCES

- A. I.S.A. – Instrument Society of America
- B. Hydraulic Institute
- C. ANSI – American National Standards Institute
- D. NEMA – National Electrical Manufacturers Association
- E. UL – Underwriters Laboratories
- F. NEC – National Electric Code

1.03 PERFORMANCE – GENERAL REQUIREMENTS

- A. The instrumentation equipment shall be furnished by a manufacturer regularly engaged in the manufacture of process instrumentation equipment and systems for water and wastewater treatment facilities. The instrument manufacturer shall produce detailed drawings for the complete coordination and installation of the various system components; shall provide the services of a qualified engineer to supervise the installation; and shall test and make any adjustments required, at no additional cost to the Owner, to the extent that the system initially functions as intended by this specification to the satisfaction of the Owner.
- B. Owner's Representative will check after the Contractor certifies that all the instruments are installed and are operating as per intended specification. The Contractor shall be required to correct, at no extra cost to the Owner, all deviations and/or deficiency from the intended use of the instruments individually as well as the system in its entirety, which the Owner's Representative may find during the detail checkup of the system(s).

- C. Equipment shall be located and installed so that it will be readily accessible for operation and maintenance. The Contractor shall examine the architectural, structural, mechanical, electrical, and shop drawings for the various pieces of equipment in order to determine the exact routing and final terminations for conduits and signal lines. Instrumentation work shall be carefully coordinated between the various trades in order to secure the best arrangement of the work as a whole. No changes in the work shall be made without written acceptance of the Owner.
- D. The Instrument Contractor shall submit evidences of his prior experience, technical skill, capacity to handle a project of the volume and reference of other clients for whom he has performed similar installations.
- E. Services by Manufacturer and Guarantee:
 - 1. Certification sheets shall be prepared by the Instrumentation Manufacturer to guarantee that each component has been calibrated and commissioned prior to start-up. Certification sheets shall be signed and dated by the Instrumentation Manufacturer. All instruments shall be calibrated by an instrument traceable to a primary standard. All instruments shall be calibrated to within the accuracy stated by the manufacturer. Each instrument shall be checked for zero and full span and in addition, a check shall be made of a minimum of 5 points between 10 and 90 percent of the actual span for each analog instrument. The certification sheets shall show "as found" and "as left" readings.
 - 2. After all tests and adjustments have been made, the manufacturer shall fully instruct the Owner's Representative in all details of operation and maintenance of equipment installed under his work.
 - 3. The Contractor and his surety shall guarantee in writing for a period of one year from the date of final acceptance that all materials, equipment and labor furnished by him are free from defects. The Contractor shall further guarantee that if any piece is found to be defective within the guarantee period because of faulty manufacturing, faulty installation or workmanship, in the opinion of the Owner's Representative, the Contractor will replace and install such material or equipment without any additional expense to the Owner.
- F. Installation, Calibration, Commissioning and Start-Up Assistance:
 - 1. Install, calibrate, commission and assist in the start-up of instrumentation and controls including those furnished with purchased equipment in accordance with this specification section, the applicable design drawings and other Contract Documents.
 - 2. Furnish and install all necessary instrumentation materials and piping required to perform the work.

1.04 GENERAL INSTRUMENT CONSTRUCTION

- A. Attachments and Supports:
 - 1. All instrumentation and electrical equipment shall be securely supported. It shall be the responsibility of the Contractor to provide adequate support for all equipment he installs. Methods of support shall be subject to the approval of the Owner.
 - 2. All fastenings, supports, hangers, clamps, and anchors shall be of the type made for the specific purpose for which they are to be used. Toggle bolts or machine bolt fastenings shall be used for hollow tile, terra-cotta, or lath construction. Machine

screws shall be used for structural steel fastening. Lead expansion shield and machine screws shall be used for solid masonry fastening. Lag screws or bolts shall be used for wood fastening. All conduit and tubing shall be rigidly and firmly installed to prevent swaying, vibration or sagging by malleable or wrought steel hangers of standard design, pipe clamps, or fabricated steel supports of approved design. Hangers for horizontal conduit runs shall be adjustable clevis type. Perforated strap iron hangers are not permitted.

3. All exterior fastening devices shall be Series 304 stainless steel.
4. Panels and other equipment that are located on subgrade walls in unfinished areas or in damp locations, shall be mounted on square aluminum channel.

B. Identification Nameplates:

1. All sensors, transmitters, terminal and junction boxes, and similar or related items shall be identified by name, function, and/or control. Nameplates shall be at least 1" x 3" with characters not less than ¼ inch. They shall be made up of 2 laminated white plastic sheets bonded with a middle sheet of black plastic and characters engraved in one white sheet to the depth of the black plastic. Nameplates shall be attached with sheet metal screws or bolts and nuts.
2. Plastic tape embossed nameplates will not be acceptable.

C. Instructions:

After all tests and adjustments have been made, the Contractor shall fully instruct the representatives of the Owner in all details of operation and maintenance of equipment installed under his work.

D. Materials:

1. All material shall be new, free from defects, and of the quality specified or shown. Each type of material shall be of the same manufacture throughout the work. All material shall be the product of established, reputable manufacturers normally engaged in the production of the particular item being furnished.
2. Care shall be exercised in the installation of all equipment to avoid damage or disfiguration of any kind. All equipment shall be protected from dust and moisture prior to and after installation. The panels and consoles shall be covered with a heavy polyethylene plastic sheet or laminated kraft paper having a moisture barrier during all stages of construction.
3. Equipment which is stored in unheated or open areas on the job site shall be provided with thermostatically controlled heating units of sufficient size to keep the temperature of the equipment above the dew point.
4. Failure of the Contractor to protect the equipment as outlined herein shall be grounds for rejection of the equipment.

E. Indicating Scales:

All instrument components furnished under this Contract requiring indicating scales or meters shall be furnished with the appropriate ranges and engineering units. Indicating scale reading 0-100 percent will not be acceptable.

1.05 TESTING, CALIBRATION AND COMMISSIONING

As preparation for the calibration and commissioning of the instrumentation, the Contractor shall:

- A. Visually inspect electrical devices and connections for compliance with specifications, drawings and manufacturer's recommended installation practice.
- B. Remove all shipping stops and install components such as charts, etc., which have been supplied separately but are integral parts of the instruments.
- C. Operationally check all instruments, including those provided with equipment and marked on the "Piping and Instrument Diagrams". After, or during checking, each instrument shall be calibrated and commissioned.
- D. Furnish and report forms recording the calibration of all devices and settings of all final adjustments.
- E. Check calibration of all instruments with respect to zero, span and linearity. Calibrate instruments individually. Attach a calibration sticker to each item after calibration. Furnish a signed calibration report for each instrument.
 - 1. If, during calibration procedures, any reason is discovered to question the conformance of any device or installation with applicable codes and regulations, the Owner shall be notified so that corrective measures may be taken.
 - 2. When doubt exists as to the correct method of calibrating an instrument, the manufacturer's printed recommendations shall be used.

1.06 INSTRUCTION MANUALS

The Contractor shall provide the Owner with three (3) complete sets of manufacturer's operating and maintenance instructions and recommended spare parts lists for all instrumentation equipment furnished.

PART 2 – PRODUCTS

2.01 IN-LINE MAGNETIC FLOW METERS

- A. In-line flow meters shall be installed on all new pump stations with rated pump flow equal to or greater than 400 gpm.
- B. Size as shown on Contract Drawings.

- C. Flow Meter Characteristics:
1. Accuracy: $\pm 0.25\%$ of rate > 2.0 fps; $\pm 0.50\%$ for < 2.0 fps.
 2. Flow range: 0 – 2 fps minimum to at least 30 fps maximum.
 3. Environmental Protection: NEMA 6 and IP68 indefinitely submersible to 30 feet water column.
 4. Grounding electrode on each sensor.
 5. Field replaceable sensors.
 6. Electrodes: AISI 316 stainless steel.
 7. 120 V, 60 Hz transmitter supply.
 8. ANSI 150 RF flanged connections.
- D. Transmitter:
1. Wall-mounted UV resistant fiberglass with lockable stainless steel latches.
 2. Cable entry: 4 non-threaded holes for $\frac{1}{2}$ " conduit.
 3. Ambient temperature range: -4° to 158°F .
 4. Analog outputs: two (2), 4-20 mA outputs from separate terminals.
 5. Pulsed outputs: one (1) externally powered, 2-wire scaled output.
 6. Communication output: HART Protocol, RS232.
 7. Relay outputs: 2 user configurable form C.
 8. Contact Inputs: 2 user configurable.
 9. Non-full pipe detection.
 10. Analog Inputs: two (2) 4-20 mA inputs with 2-wire, 18V DC supply.
 11. Display: 4 lines of 20 character of waterproof, backlit LCD display.
 12. Front panel keyboard: tactile feedback, waterproof sealed.
 13. Diagnostics: all necessary diagnostics, readings and system status to be available via front panel keypad without opening the door.
 14. Windows interface connection via serial connection.
- E. Meter and transmitter shall be manufactured by Advanced Flow Technology Company, UniMag DS Series, Magnetoflow Mag Meter with remote Primo Amplifier by BadgerMeter, Inc.

2.02 CLAMP-ON FLOW METERS

- A. Where clamp-on flow meters are specified for installation on existing piping, the following shall apply:
1. AquaTrans™ AT868 as manufactured by GE Infrastructure Sensing.
 2. Clamp-on flow transducer.
 3. Suitable for use with clean water and liquids with entrained solids and air bubbles.
 4. Suitable for use on ductile iron or PVC pipe.
 5. Flow Accuracy
 - a) $\pm 2\%$ to 5% of reading on pipe ≤ 6 -inch.
 - b) $\pm 1\%$ to 2% of reading on pipe > 6 -inch.
 6. Repeatability: $\pm 0.1\%$ to 3% of reading.
 7. Range: -40 to 40 ft/sec.
 8. Rangeability: overall 400:1
 9. Measurement Parameters
 - a) Volumetric flow
 - b) Totalized Flow
 - c) Flow Velocity

10. Mounting: as shown on Contract Drawings.

B. Electronics

1. Correlation Transit-Time mode.
2. Enclosure: NEMA 4X.
3. Channels: One.
4. Display: 2-line x 16 character backlit LCD display, configurable to display up to four measurement parameters in sequence.
5. Six button internal keypad.
6. Power supply: 85 to 265 VAC, 60 Hz.
7. Operating Temperature: 14° - 158°F.
8. Standard Input/Output: one (1) 4-20 mA isolated output per channel. 600 ohm maximum load.
9. RS 232 Interface.

C. Clamp-On Ultrasonic Flow Transducer

1. Temperature Range: - 40° to 140°F.
2. Mounting: stainless steel chain or strap.
3. Weatherproof NEMA 4 submersible.
4. Cable: one pair of coaxial cables, type RG62 AU; distance as required by field conditions.

2.03 TELEMETRY

A. General:

1. All telemetry shall be supplied by one supplier and shall be compatible and integrated into the existing Foxboro SCADA system operated by the City using open system interconnect.
2. All telemetry data shall be received by the master SCADA unit located at the Clarksville Gas and Water Main Office located at 2215 Madison Street.
3. All new equipment shall be Foxboro to match existing components.
4. Manufacturer shall provide the Owner with updated telemetry system documentation after the installation of new equipment is completed.
5. Manufacturer shall conduct a site survey of the proposed sites to guarantee line of radio communication between new radio and the nearest repeater station. Repeater station shall also communicate with master unit.
6. At a minimum, telemetry for new pumping stations shall be capable of monitoring the following station functions:
 - a) Pump status for all pumps (off-on).
 - b) Power failure.
 - c) High wet well level alarm.
 - d) Pumped flow.
 - e) Man down.
 - f) spare digital input/output.
 - g) spare analog input/output.

- B. Data Acquisition and Multi-Loop Control Unit requirements:
1. Modbus communication.
 2. Provide signal conditioning, alarm monitoring, remote data acquisition and developed control.
 3. Base unit shall include internal I/O bus and mounting supports, an Input Output Controller, and analog and digital modules to meet the requirements of signals to be monitored.
 4. Live plug-in capability.
 5. Diagnostic LED's.
 6. Operating temperature 0 - 55°C with 5° to 95° non-condensing relative humidity.
 7. Manufacturer: Invensys-Foxboro Model 2500.
- C. Radio requirements:
1. Frequency-hopping spread spectrum radio operating in the license free 902-928 MHz Band.
 2. 1 watt receiver.
 3. Allow for communication up to 25 miles, line of sight.
 4. User-configurable encryption key.
 5. RS-232 serial data port.
 6. Remote control, statistics, diagnostics.
 7. 10-30 VDC power supply.
 8. Operating environment, - 40° to 75°C.
 9. Extruded aluminum, powder coated enclosure.
 10. Reverse gender antenna connector.
 11. LED indicators for power, transmit, receive, and signal strength.
 12. Function as a master, slave or repeater unit.
 13. Meet requirements of FCC Part 15.247 and IC RSS210.
 14. Manufacturer: American Control Technologies, Model IP920 Wireless Ethernet Bridle/Serial Gateway Data Hopper.
- D. Antenna requirements:
1. Omnidirectional.
 2. Gain as determined during site survey (6 or 9 dBd).
 3. Moisture resistant.
 4. Lightning resistant.
 5. Suitable for use with 902 - 928 MHz radio.
 6. Stainless steel mounting hardware.
 7. Dual purpose mounting unit.
 8. Mast: Height and configuration as determined by field site survey.
 9. ½" coaxial cable of length to connect antenna and radio with coaxial cable connectors.
- E. UPS:
American Power Conversion Backup UPS RS 1000/VA 1500VA.
- F. Control Panel requirements:
1. Minimum size, 24"(w) x 36"(h) x 16"(d), NEMA Type 4,12 with lockable door.
 2. Square D DPDT 120 VAC relay with pilot and operator.
 3. 20 amp simplex receptacle for UPS.
 4. 20 amp duplex receptacle for convenience.

5. 10 amp breaker.
6. 120 VAC surge arrestor
7. Piloted fuse blocks.
8. Grounding bar.
9. Wireway as needed.
10. Mounted external to pump station on galvanized steel post or unistrut set in concrete.

2.04 WIDE AREA WIRELESS TELEMETRY (SMALL STATIONS)

A. General:

1. The equipment to be furnished will be the product of a qualified firm that is regularly engaged in the manufacture and/or supply of this type of equipment. A qualified firm will be defined as one that has manufactured and sold 100 of the specified units during the last two years.
2. It is the intent of the specifications to secure equipment that can be maintained and serviced without necessity of stocking expensive parts inventory or being subject to long periods of interrupted service due to lack of spare parts.
3. The company, shall have on staff, engineering and operation personnel with at least five years experience in designing, manufacturing and operating wide area wireless telemetry systems, microprocessor based monitoring systems and interactive, remotely accessible (Internet or otherwise) database management systems and computer telephony.
4. The company shall be the actual manufacturer and operator, or a duly authorized and trained agent of the manufacturing company or a combination of both, who will actually provide, maintain and warranty the system.
5. The manufacturing company of the field equipment shall also be the provider of all monitoring related services associated with the field equipment and all ongoing service agreements will be with the actual company providing the monitoring service, not a subContractor or agent.
6. The company shall provide 24/7 technical support.
7. The company shall be able to provide field equipment that either transmits alarms only and daily status events or continuously transmits all digital, analog and pulse inputs on an "as occurs" basis or at least once every two (2) minutes and the City may choose to utilize either type of field unit at any proposed site.
8. The systems shall be equivalent to the Mission Communications C110 GSM/GPRS RTU or Omni-Site XR-50 GSM/GPRS Generation 3.5 RTU systems.

B. Field Hardware Requirements:

1. All field hardware shall come enclosed in a NEMA 4X durable steel or similar enclosure capable of housing all electronics and backup batteries.
2. The field hardware shall have at least 8 digital (dry contact) inputs.
3. The field hardware trip inputs must have end of line resistor supervision or similar supervision that can detect normal alarm trip inputs and detect input wiring disconnection as a distinctly different signal and report.
4. The field unit shall be capable of reporting for each input alarm, return to normal and fault condition.
5. The field unit shall be made available with a radio that transmits alarms only and daily status events.

6. The field unit shall have on-board diagnostic enunciator lights for each digital input, which indicate real time the state of the dry contact inputs.
7. The field unit shall have at least two (2) analog inputs (0-5 Vdc or 4-20mA) of at least 10 bit resolution. Each analog input shall have at least 4 threshold alarm set points.
8. The field unit shall be capable of reporting analog threshold alarms, daily high/low analog values and /or current analog values.
9. The field hardware trip inputs must operate normally when either side of the trip inputs circuitry is shorted to ground and send a trouble signal upon detection of such short to ground.
10. The field hardware trip inputs must have a programmable trip input detection delay between 0 and 90 seconds.
11. The field units shall have on-board diagnostics that indicate received signal strength of the wireless carrier's signal, wiring faults and message transmission progress and status.
12. The field hardware unit shall have some methodology that enables a single input to be temporarily disabled that does not conflict with the disabled inputs end of line resistor or wiring supervision method.
13. At least three of the field hardware trip inputs must be capable of being programmed to record and report pump run times as indicated by a relay opening and closing for up to three pumps. If only two pumps are monitored, then the unit shall also record and report simultaneous pump run times.
14. The unit shall record and report individual pump starts on a one day or seven day basis. The unit shall also have the ability to report within one (1) hour any individual pump starting in excess of a preprogrammed amount. The excess pump start messages shall be automatically forwarded to City via pager, email or fax.
15. The field unit shall be optionally capable of counting voltage pulses or contact closure from two different sources and reporting those pulse counts daily or as they occur. This shall be in addition to the other inputs described above.
16. The field unit shall have a means of being put in local shut down without powering the unit down. This shall effectively stop any alarms from being either transmitted from the unit or sent from the central computer facility. The action of putting a field unit in local shut down mode must be authorized and documented via an electronic access control key or card reader. The act of the local shutdown shall be recorded, along with the name of identity of the person performing the local shut down at the central computer facility.
17. The field hardware shall monitor its primary AC power supply input and shall be capable of sending an AC failure alarm. The unit shall delay the AC failure report for 300 seconds. The unit shall report AC power restoration.
18. The field hardware shall have a built-in supervised battery backup power supply. This power supply shall be tested and operate the equipment for at least 15 seconds every day. The unit shall detect and report any backup battery power supply test failure.
19. The field unit shall have a built-in electronic key or card reader which will, when activated, cause the central monitoring/alarm notification facility to cancel any in-progress alarm notifications for that field unit. Additionally, the key use will prevent any subsequent alarms from being processed for a period of one hour, and record at a central facility the time and name of the electronic key used for the activation. Alarm notifications will resume when the electronic key is used again or automatically resume one hour after the last alarm message was sent from the monitored site.

20. The field unit shall have the capability of being shut down from transmitting any alarms by use of a push button switch. The push button switch shall be activated by use of an electronic key or card. The unit shutdown switch will not allow unit shut down until said electronic key or card has been used within the preceding one minute. The electronic key or card use and the subsequent unit shut down shall be transmitted immediately and the event be logged at the central computer. The field unit shall be capable of re-enabling itself for alarm use by a subsequent electronic key or card use or subsequent push button activation and shall automatically re-enable at midnight. Such re-enabling shall be transmitted to the central computer for logging.
21. The field hardware shall utilize a transmission scheme and subsequently report individual transmission failures.
22. The field hardware shall utilize, in the case of a continuously transmitting field unit, a transmission scheme that encrypts the transmitted data utilizing an 128 bit encryption method that meets or exceeds the advanced encryption standard (AES). Additionally, the continually transmitting field units will have an effective, continuous transfer rate of at least 19,200 baud.
23. The field hardware unit shall utilize a transmission scheme that individually identifies each transmitted message by sequence number.
24. The field hardware shall optionally be capable of sending test transmissions at least every seven days and have the capability for daily and on-demand test transmissions of transmitting a signal at least once a minute.
25. The field hardware test transmissions shall indicate current and historical radio signal reception quality and shall report radio signal outage and the duration of the outage.
26. The field hardware must be capable of reporting, on-demand or on-schedule, operational status, accumulated pulse input values, pump run time durations and current operation status of normal alarm trip inputs (trouble, alarm, normal states).
27. The field unit shall be capable of being put into a service mode at the remote site and such service mode operations shall be logged and accessible to the customer at a central monitoring facility.
28. The field unit shall be capable of optionally providing a method to monitor the wet well float circuit directly while providing auxiliary wet well alarm relay contact closures without the addition of a separate high wet well float. This optional circuitry shall detect high wet well conditions in the event of pump station AC failures.
29. The field unit shall not present any electric shock hazard.
30. The field unit shall be capable of being listed as complying with the Underwriter's Laboratory requirements for remote signaling devices.
31. The system shall have a primary central monitoring and control center and a fully redundant, physically separate, backup-computer monitoring center. Either center shall have the capability of operating all the remote monitoring and control field RTUs.

C. Monitoring and Control Center Software/Hardware Requirements:

1. The monitoring center functionality and customer alarm and supervisory information must be made available to customer via secure Internet connection or other access manor acceptable to the City.
2. The monitoring center must be capable of interfacing and transferring, on a continuous basis, all RTU data to an OPC compliant database for access by other OPC compliant HMI software packages. Such transfer method will have 128 bit, or better encryption, and meet or exceed the advance encryption standard (AES).

3. The monitoring center must be housed in a secured, access-controlled facility/enclosure.
4. The monitoring center critical equipment must be supplied power from an uninterruptible power source capable of stand-alone operation for at least 12 hours.
5. The monitoring center customer Internet Web site shall provide the City with on-demand capability of shutting down/waking up individual units, remotely status testing individual units, remotely controlling individual units on-board relay, individually polling units for current trip inputs or accumulator input status and values, and be capable of remotely reprogramming other critical field unit operating parameters.
6. The monitoring center shall provide individual log on access and operations security levels as well as require logged, individual acceptance/acknowledgement of all presented alarms or supervisory messages.
7. The monitoring center shall provide an easy to use/understand general system overview graphic representation of the current state of all remote points being monitored by the system.
8. The monitoring center shall provide screens that can display the current status or value from field units that provide continuously transmitted digital, analog, or pulse counting data.
9. The monitoring center shall provide screens that can display historical data trends in a graphic format from field units that provide continuously transmitted digital, analog or pulse counting data.
10. The monitoring center shall provide the ability to manually control field unit relays from field units that provide continuously transmitted digital, analog or pulse counting data. All such control functions shall be password protected and logged in a secured database.
11. The monitoring center shall provide for the remote command and control of the customers monitored field hardware in a manner consistent with the field unit's capabilities. The access to this remote command and control functionality shall be security level controlled and all events of use logged in a secure database.
12. The monitoring center shall provide functions for the City to add/delete/change a field unit's alarm notification delivery methodologies and destinations.
13. The monitoring center shall provide easy to understand and use screens for the City to securely access, globally or individually, alarms, testing and notification results for the field monitoring units.
14. The monitoring center shall provide a methodology to enable/disable an entire unit from reporting, or any of the unit's individual inputs from reporting with such enabling/disabling to be time scheduled.
15. The monitoring center must have a methodology to track the results of all alarm notifications as to its success or failure. If alarm notifications fail, a log of said procedures and their causes shall be provided.
16. The monitoring center must have the ability to analyze and display, graphically or tabular, all pump runtimes on a daily basis. The pump runtime analysis shall use regression analysis over the preceding thirty days. The analysis shall have preset variance limits, which when exceeded, automatically cause emails, pages or faxes to be generated to a customized list of recipients.

D. Notification Capabilities Requirements:

1. The monitoring center shall be equipped with adequate communications links to provide reasonable assurance that alarms will be delivered via any chosen delivery methodology to selected recipients within 30 seconds of the monitoring center receiving such alarms from field equipment.
2. The monitoring center shall be capable of automatically delivering alarm or other selected message to numeric pagers, alphanumeric pages, email addresses, facsimile machines or voice telephones (hardwired or wireless, local or long distance). Such delivered messages will include a cancellation/acceptance code (or other such methodology) that is used by the recipient to indicate the monitoring system that the recipient has received/accepted the sent message. All message notification attempts, failures and delivery/acceptance confirmations will be logged.
3. The monitoring center shall be capable of scheduling alarm notifications to recipients by time of day, day of week, holiday and input type.
4. The monitoring center shall be capable of delivering to the alarm notification recipient the pump running status of all monitored pumps at the monitored site in the same alarm notification message as the initiating alarm message.
5. The monitoring center must have the ability to suppress erroneous digital alarms that occur in conjunction with AC power failures.
6. The monitoring center must have the ability to selectively suppress repeat or duplicate alarms from a particular field unit and a particular input.
7. The monitoring center shall be capable of buffering AC power failure messages for a City-defined amount of time and then issuing a single group alarm notification message that embodies a list of all of the monitored sites that have an AC power failure. The same group alarm notification function shall apply to monitored sites that have AC power restoring to normal.
8. The monitoring center shall store all system messaging transaction, operator commands, notification attempts and message delivery confirmations in a secure, non-alterable database.
9. The monitoring center shall automatically report and notify customer designated recipients of RTU telemetry link loss within five minutes of link loss for continuous telemetry RTUs, or twenty five hours of link loss for daily reporting RTUs.

E. Administrative Reports Requirements:

1. The monitoring center shall provide the customer with automatically generated, weekly reports of all alarms, notifications, delivery confirmations/acceptances and unit test failures. Such weekly reports shall be automatically faxed or emailed to up to four (4) City-designated recipients.
2. The monitoring center shall be capable of generating historical reports of any/all field monitoring unit's alarms, notifications, delivery confirmations/acceptances and test failures.
3. The monitoring center shall automatically archive all logged system activity on a daily basis to a physically separate database and computer.
4. The monitoring center shall analyze (by percent variance or regression analysis) all pump routines on a daily basis and automatically generate and send via fax or email out-of-bounds reports to up to four (4) recipients.
5. The monitoring center must have the ability to display, by site or by electronic key-holder, all uses of the electronic key for at least a month's period of time. Such electronic key use records will be accessible in a report form for hard copy storage.

6. The monitoring center must have the ability to transfer alarm, electronic key use, analog values, pulse count values, and pump run times to other computers via a comma-delineated text string file transfer so as the data can be imported into other generally accepted spreadsheet computer programs.

PART 3 – EXECUTION

3.01 MANUFACTURER’S SERVICES

- A. All manufacturer’s visits to construction site prior to final performance test shall be the responsibility of the Contractor. The Contractor shall furnish the Owner with services of equipment manufacturers’ representatives for a period of 1 man-day.
- B. Applicable Contract prices shall include the furnishing of all said services. Furthermore, said services shall be additional to those furnished in connection with equipment erection, installation, testing and the correction of deficiencies. Services provided shall consist of furnishing detailed instructions to personnel of the Owner regarding equipment operation and maintenance.

3.02 INSTRUCTION MANUALS

- A. Contractor shall furnish, prior to initial testing, three (3) copies of an indexed maintenance manual composed of supplier’s maintenance manuals on all equipment and supplier’s brochures on all specialty equipment, including performance curves with size, model, figure number, etc., indicated to identify unit furnished. Maintenance manuals are to be a hardback, loose-leaf type and of a durable quality. Manuals are to be for the specific equipment provided. Manuals describing general equipment lines will not be accepted.
- B. Each set is to include the following:
 1. Manufacturer’s parts list identified with the make, model and serial number of the equipment furnished.
 2. Control and wiring diagrams.
 3. Installation, operation, and maintenance instructions.

END OF SECTION

SECTION 16010

GENERAL ELECTRICAL PROVISIONS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, material, tools and services for a complete installation of equipment and systems specified herein.
- B. No project is considered complete unless it is functional.

1.02 QUALITY ASSURANCE

- A. Comply with applicable local, state and federal codes.
- B. Comply with applicable requirements of recognized industry associations that promulgate standards for the various trades.
- C. Employ only qualified journeymen for this work. Employ a competent qualified electrician to supervise the work.

1.03 STANDARDS

- A. Perform work specified in Division 16 in accordance with standards listed below including amendments or revisions. When these specifications are more stringent, they take precedence. In case of conflict, obtain a decision from the owner's representative.
- B. National Fire Codes (NFPA) including, but not limited to following:
 - 1. NFPA-70 - National Electrical Code. Most recent edition adopted by the City of Clarksville.
 - 2. NFPA-101 - Life Safety Code. Current Edition.
- C. Applicable codes:
 - 1. Standard Building Code. Current Edition.
 - 2. ANSI Handicapped Code - A117.1. Current Edition.
 - 3. Applicable State Energy Code. Current Edition.
 - 4. City of Clarksville Electrical Code. Current Edition.
 - 5. State of Tennessee "Chapter 0780-2-1 Code," 1981 Edition.
- D. Should any work be construed as being contrary to or not conforming to aforementioned codes, such alleged conflict shall be brought to attention of Engineer in writing ten (10) days prior to bid date for review so that such point in question may be resolved. All work to be installed in strict conformity with applicable codes without additional cost to Owner.

- E. Contractor shall submit and/or file with proper authorities all necessary specifications and drawings as required by governing authorities.

1.04 SUBMITTALS

- A. Submit letter from each equipment manufacturer stating that equipment furnished will withstand horizontal forces evaluated using a "Cp" factor of 0.2 applied in any direction. See mechanical drawings for seismic bracing and anchorage of equipment being furnished under this Division.
- B. Within fifteen (15) days after contract has been awarded, Contractor shall submit to Engineer for approval a complete list of materials, equipment, and accessories proposed for use, listing the item and manufacturer's name only.
- C. Based upon aforementioned approved listing, Contractor shall submit three (3) copies for the Owner's use plus any additional copies required by the Engineer of COMPLETE BROCHURES AND SHOP DRAWINGS OF ALL MATERIALS, FIXTURES AND EQUIPMENT that Contractor proposes to use, giving the names of manufacturers, trade name and specific catalog numbers.
- D. Brochures to be submitted in time to allow 15 days from date of receipt in Engineer's office before final approval or disapproval is required to meet construction schedule. Submittals to bear Contractor's stamp of approval evidencing he has examined and checked same and information contained therein is in accordance with contract requirements, and any deviations to be clearly marked. Approval of shop drawings not to be construed as permitting departure from the contractual documents.
- E. Above mentioned brochures to be submitted and approved by Engineer before any materials are installed.
- F. Proposed items to be clearly indicated when other items are shown on same sheet. When proposing items other than those specified, brochures to contain both specified item sheets and proposed item sheets for ease of comparison. On request from Engineer samples shall be submitted and/or set up, as directed, for inspection and approval. Samples will be returned to Contractor.
- G. Shop drawings: Submit specific shop drawings for major materials where called for or when requested by Engineer.

1.05 OPERATING AND MAINTENANCE MANUALS

- A. Prior to final acceptance of the project, furnish to the Owner complete three (3) bound sets of operation and maintenance manuals for all pieces of equipment and systems provided under this division of specifications.
- B. Manuals to also include all submittal data on all materials and equipment. Clearly indicate items provided on this project. A list giving name and address of nearest supply house carrying spare parts and name of Installation Subcontractor to be given to Owner.

- C. Verbally instruct Owner's Representatives in the start-up, operation and maintenance of all equipment provided. Contractor to obtain letter signed by the Owner's Representative indicating that the in-service training has been completed.
- D. Arrange each set of data in an orderly way, and bind each set in a separate 3-ring, hard-cover binder.
- E. As soon as data accumulates, prepare one of the sets and deliver to the Owner's Representative. Continuously update this set as additional data is obtained.
- F. At completion of work, submit three complete sets of data to the Owner's Representative.

1.06 DELIVERY AND STORAGE

- A. Insofar as possible, deliver items in manufacturer's original unopened packaging. Where this is not practical, cover items with protective materials, to keep them from being damaged. Use care in loading, transporting, unloading, and storage to keep items from being damaged.
- B. Store items in a clean dry place and protect from damage.
- C. All damaged painted surfaces of equipment to be touched up to match original paint.

1.07 RECORD DRAWINGS

- A. Keep a set of project drawings at the job site exclusively for recording deviations from the drawings which are necessary because of job conditions.
- B. Mark deviations in colored pencils so that work of various systems can be easily identified.
- C. When work is completed, record all deviations on drawings and return to the Owner. AutoCAD compatible drawings may also be required.
- D. Contractor shall submit corrected drawings to the Owner as record copies within six weeks of acceptance of the project.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

All materials and equipment used in carrying out these specifications shall be new and have UL listing, or listing by other recognized testing laboratory when such listings are available. Specifications and drawings indicate name, type, and catalog numbers of materials and equipment to be used as "standards" and shall not be construed as limiting competition. Contractor may at his option, use materials and equipment when, in the judgment of the Engineer, they are equivalent to that specified and are approved by the Engineer prior to starting work or ordering material.

PART 3- EXECUTION

3.01 COORDINATION

- A. Deviations:
 - 1. No deviations from specifications and drawings shall be made without full knowledge and consent of Engineer.
 - 2. Should Contractor find during progress of work that existing conditions make desirable a modification of the requirements of any particular item, report such item promptly to Engineer for his decision and instructions.
- B. Insofar as it is possible to determine in advance, leave proper chases and openings. Place all outlets, anchors, sleeves, and supports prior to pouring concrete or installation of masonry work. Should the Contractor neglect doing this, any cutting and/or patching required to be done is at this Contractor's expense.
- C. Visit site and be informed of conditions under which work must be performed. No subsequent allowance will be made because of error or failure to obtain necessary information to completely estimate and perform work involved.
- D. Coordinate to assure that proper points of service transformer locations, voltage characteristics and capacity of service are in accordance with Contract Drawings.

3.02 CUTTING AND PATCHING

- A. Repair or replace routine damage caused by cutting in performance of this contract.
- B. Correct unnecessary damage caused due to installation of electrical work, brought about through carelessness or lack of coordination.
- C. Holes cut through existing floor slabs or walls to be core drilled with drill designed for this purpose. All openings, sleeves and holes in slabs between floors or walls to be properly sealed, fire proofed and water proofed.
- D. Repairs to be performed with materials that match existing materials and to be installed in accordance with appropriate sections of these specifications.

3.03 TRENCHING, EXCAVATION, BACKFILLING, AND REPAIRS

Provide trenching, excavation, and backfilling necessary for performance of electrical work in accordance with Section 02221 and the governing power company.

3.04 FOUNDATIONS AND PADS

- A. Contractor to furnish and install all foundations and pads required for equipment provided under this division of specifications. Contractor to be responsible for proper size and location of foundations, pads, anchor bolts and other items to be built into structure.
- B. Concrete to be in accordance with Section 03300 of these specifications.

3.05 TESTS

- A. On completion of work, installation shall be entirely free from grounds, short circuits, and open circuits. Perform a thorough operational test in presence of Owner or his representative. Balance all circuits so that feeders to panels are not more than ten percent out of balance between phases with all available loads energized and operating. Furnish all labor, materials and instruments for above tests.
- B. Prior to final observation and acceptance, test and leave in satisfactory operating condition all electrical systems and equipment.

3.06 INSPECTION FEES AND PERMITS

Obtain and pay for all necessary permits and inspection fees required for electrical installation.

3.07 IDENTIFICATION OF EQUIPMENT

Properly identify all boxes with permanently attached black phenolic plates with 1/4-inch white engraved lettering on the face of each attached, with two sheet metal screws. Starters and relays connected by the Contractor shall be identified. CLX cable and conduit systems containing 15 KV cables shall be identified with "15 KV" markings and/or phenolic plates as previously described.

3.08 TEMPORARY LIGHTS AND POWER IF REQUIRED

- A. Provide a temporary electrical lighting and power distribution system of adequate size to properly serve the following requirements, including adequate feeder sizes to prevent excessive voltage drop. Temporary work to be installed in a neat and safe manner in accordance with the National Electrical Code and as required by OSHA or applicable local safety codes.
- B. Check prior to installation to determine if any lighting or power outlets over the maximum quantity noted above are required.
- C. Provide service tap and panelboards required for above lighting and power outlets. Verify tap location with Engineer prior to starting work.
- D. Power consumption will be paid for by the Contractor.
- E. Contractor to maintain the existing lights and power during normal regular hours as directed by Owner. Any interruption of power must be approved by and coordinated with Owner's representative.

3.09 DEMOLITION

- A. Schedule all demolition work as to cause minimal interference with facility operations and to comply with provisions of these specifications.
- B. Obtain prior approval of the Owner at least seven days in advance before starting demolition of any equipment. Under no circumstances will demolition work be approved until new equipment is ready for installation.
- C. Disconnect or arrange for disconnection of utility service connections to equipment and areas to be demolished before starting demolition.
- D. Preserve in operating condition all active utilities transversing the project site. Protect all equipment that remains (electrical and mechanical) during demolition, and repair all damage caused by this work to satisfaction of Engineer.
- E. Maintain the continuity of the existing branch circuits serving all existing light fixtures that are to remain, whether indicated or not on the drawings.
- F. All existing walls, ceilings, floor slabs, etc., being cut or damaged under this contract to be patched back to match existing.
- G. All existing switchgear, lighting fixtures, receptacles, control equipment and switches being removed to be cleaned and turned over to the Owner.
- H. Remove exposed ground conductor back to source or point of contact with slab. Cut conductor off below slab and abandon with hole being patched back to match existing surface (floor, wall or ceiling). If reusable, simply disconnect ground conductor.
- I. Conduits, wire and wood products that are not salvageable shall be disposed of legally.
- J. Primary work shall be completed with all facilities kept in service or with short periods of scheduled momentary outages.
- K. Holes in slabs or into classified areas to be patched to provide a gas, vapor and watertight barrier.
- L. The Owner reserves the right to save materials that are a part of the demolition work, and the Contractor shall turn over and store any such materials at the Owner's direction.
- M. All materials not turned over to Owner shall become property of Contractor and removed promptly from plant site at no additional cost to the Owner. Any permits or fees for disposal shall be the responsibility of the Contractor.

- N. Burn no materials or debris on premises.
- O. Remove from site rubbish and debris found thereon and, except as otherwise specified, materials and debris resulting from work of demolition. Leave site in safe and clean condition.

3.10 OBSERVATIONS

- A. The Engineer or his representative will provide periodic observation of the progress of work specified herein and will also observe tests required of Contractor as called for in other sections of specifications.
- B. Specifications and drawings represent work to be done in view of total project requirements. Final location of conduits, switchgear, etc., to eliminate possible conflict with existing equipment is responsibility of Contractor. Contractor to provide all supervision required for his personnel to insure that installation is made in accordance with specifications and drawings and all safety rules and regulations are observed. In event of conflicts of work on project with other trades, Contractor to make every reasonable effort to resolve conflict through meetings and discussions with other parties involved, by preparation of drawings or other appropriate action. Only after this has been done shall the Engineer's assistance be requested.

3.11 WARRANTY-GUARANTEE

- A. Engineer reserves right to accept or reject any part of installation that does not successfully meet requirements as set out in these specifications.
- B. Contractor shall and hereby does guarantee all work installed under this division shall be free from defects in workmanship and materials for a period of one year from date of final acceptance. The Contractor shall repair and replace any defective material or workmanship which becomes defective within the terms of this warranty-guarantee at no additional cost to the Owner.

END OF SECTION

OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH STUDY

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Section includes short circuit, protective device coordination and Arc Flash study encompassing portions of electrical distribution system from normal power source or sources up to and including main breaker in each panelboard.
- B. Contractor shall engage services of independent engineering firm for purpose of performing electric power system studies as specified.

1.02 REFERENCES

- A. Institute of Electrical and Electronics Engineers: IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).
- B. National Fire Protection Association: NFPA 70 - National Electrical Code.

1.03 DESIGN REQUIREMENTS

- A. Complete Short Circuit, Protective Device Coordination, and Arc Flash Study to meet requirements of NFPA 70 and NFPA 70E.
- B. Report Preparation:
 - 1. Prepare study prior to ordering distribution equipment to verify equipment ratings required.
 - 2. Perform study with aid of computer software program.
 - 3. Calculate short circuit interrupting and, when applicable, momentary duties for assumed 3-phase bolted fault short circuit current and phase to ground fault short circuit current at each of the following:
 - a) Utility supply bus.
 - b) Medium voltage air interrupter switchgear.
 - c) Medium voltage circuit breaker switchgear.
 - d) Secondary unit substations.
 - e) Automatic transfer switch.
 - f) Manual transfer switch.
 - g) Engine generator.
 - h) Medium voltage motor controllers
 - i) Medium voltage oil switchgear.
 - j) Low-voltage switchgear.

- k) Switchboards.
- l) Motor control centers.
- m) Distribution panelboards.
- n) Branch circuit panelboards.
- o) Each other significant equipment location throughout system.

C. Report Contents:

1. Include the following:
 - a) Calculation methods and assumptions.
 - b) Base per unit value selected.
 - c) One-line diagram.
 - d) Source impedance data including power company system available power and characteristics.
 - e) Typical calculations.
 - i. Fault impedance.
 - ii. X to R ratios.
 - iii. Asymmetry factors.
 - iv. Motor fault contribution.
 - v. Short circuit kva.
 - vi. Symmetrical and asymmetrical phase-to-phase and phase-to-ground fault currents
 - vii. Tabulations of calculation quantities and results.
 - f) One-line diagram revised by adding actual instantaneous short circuits available.
 - g) State conclusions and recommendations.
2. Prepare time-current device coordination curves graphically indicating coordination proposed for system, centered on conventional, full-size, log-log forms.
3. Prepare with each time-curve sheet complete title and one-line diagram with legend identifying specific portion of system covered by that particular curve sheet.
4. Prepare detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
5. Plot device characteristic curves at point reflecting maximum symmetrical fault current to which device is exposed. Include on curve sheets the following as applicable:
 - a) Power company relay characteristics.
 - b) Power company fuse characteristics.
 - c) Medium voltage equipment protective relay characteristics.
 - d) Medium voltage equipment protective fuse characteristics.
 - e) Low voltage equipment circuit breaker trip device characteristics.
 - f) Low voltage equipment fuse characteristics.
 - g) Cable damage point characteristics.
 - h) Pertinent transformer characteristics including:
 - i. Transformer full load current
 - ii. Transformer magnetizing inrush.

- iii. ANSI transformer withstand parameters.
 - iv. Significant symmetrical fault current
 - i) Pertinent motor characteristics.
 - j) Generator characteristics including:
 - i. Phase and ground coordination of generator protective devices.
 - ii. Decrement curve and damage curve.
 - iii. Operating characteristic of protective devices.
 - iv. Actual impedance value.
 - v. Time constants.
 - vi. Current boost data.
 - vii. Do not use typical values for generator.
- 6. Perform Arc Flash Analysis to include the following at each distribution bus:
 - a) Bolted fault current.
 - b) Arc fault current.
 - c) Protective device characteristic and arc fault duration.
 - d) System voltages and equipment class.
 - e) Working distances.
 - f) Calculated incident energy.
 - g) Calculated arc flash protective boundary.

1.04 SUBMITTALS

- A. Submit results of study in report format including the following:
 - 1. Descriptions, purpose, basis, and scope of study.
 - 2. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short-circuit duties, and commentary regarding same.
 - 3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
 - 4. Fault current calculations including definition of terms and guide for interpretation of computer printout.
 - 5. Arc flash calculations and printout of labels.
- B. Submit five (5) copies of final report signed by professional engineer. Make additions or changes required by review comments.

1.05 QUALIFICATIONS

- A. Perform study under direct supervision of Professional Engineer experienced in design of this Work and licensed at project location with minimum of five years experience in power system analysis.
- B. Demonstrate company performing study has capability and experience to provide assistance during system start up.

1.06 SEQUENCING

- A. Submit short circuit and protective device coordination study to Engineer prior to receiving final approval of distribution equipment shop drawings and prior to releasing equipment for manufacturing.
- B. When formal completion of study will cause delay in equipment manufacturing, obtain approval from Engineer for preliminary submittal of study data sufficient in scope to ensure selection of device ratings and characteristics will be satisfactory.

1.07 SCHEDULING

Schedule work to expedite collection of data to ensure completion of study for final approval of distribution equipment shop drawings prior to release of equipment for manufacturing.

PART 2 - NOT USED

PART 3 - EXECUTION

3.01 ADJUSTING

Perform field adjustments of protective devices and modifications to equipment to place equipment in final operating condition. Adjust settings in accordance with short circuit and protective device coordination study.

3.02 ARC FLASH SIGN INSTALLATION

Implement the Arc Flash sign installation requirements for electrical equipment as specified in NEC Article 110.16 Flash Protection and NFPA 70E.

END OF SECTION

RACEWAYS AND CONDUIT SYSTEMS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide a complete conduit system with associated couplings, connectors, and fittings.
- B. Conduits shall be mechanically and electrically continuous from outlet to outlet and from outlets to cabinets, pull or junction boxes.

1.02 SUBMITTALS

Submittal for products furnished under this section is not required.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. IMC or EMT conduit shall be hot-dip galvanized, or electro galvanized steel.
- B. Erickson couplings shall be used where neither length of conduit can be rotated.
- C. Conduit connectors shall use the two locknut type for EMT or IMC. Associated couplings, connectors, and fittings shall be all steel. Die cast fittings are not acceptable.
- D. Weatherproof hub shall be furnished where required, complete with sealing "O" ring or sealing locknuts.
- E. Provide polyvinyl chloride (PVC) conduit, Type 40, and associated couplings, connectors, and fittings. PVC conduit shall be UL listed and 90 degrees C UL rated.
- F. Provide aluminum conduit in areas requiring non-ferrous materials.

2.02 ELECTRICAL METALLIC TUBING (EMT)

- A. Use Electric Metallic Tubing (EMT) for:
 - 1. Branch circuits installed overhead, both exposed and concealed, installed more than 6 feet above finished floor.
 - 2. Branch circuits installed in floor slabs other than ground floor.

2.03 INTERMEDIATE METAL CONDUIT (IMC)

- A. Use Intermediate Metal Conduit (IMC) for:
 - 1. Paperboard feeders.
 - 2. Branch circuits installed in hazardous areas.
 - 3. Branch circuits and feeders installed in concrete slabs at ground floor.
 - 4. Branch circuits installed exposed below 6 feet above finished floor.
 - 5. Branch circuits installed in wet locations.
 - 6. Pendant drops.

2.04 POLYVINYL CHLORIDE (PVC)

- A. Use PVC for:
 - 1. Service entrance conduits for power.
 - 2. Riser conduits on utility poles.
 - 3. Exterior feeders and branch circuits.
- B. PVC conduit shall not be used for feeders or branch circuits inside the building except within chlorine atmosphere.

2.05 FLEXIBLE METAL CONDUIT

- A. Provide a flexible metal conduit system for the termination points at equipment that may possibly vibrate such as motors, welders, etc. The length shall not exceed 6 feet.
- B. Conduit shall be electrically continuous from outlet or conduit end to the utilization equipment.
- C. The total length of flexible conduit in any circuit shall not exceed 6 feet.
- D. Where exposed to continuous or intermittent moisture, conduit shall be liquid tight flexible type, U.L. Type EF.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Minimum size of conduits shall be ½ inch.
- B. Conduit joints shall be cut square, threaded, reamed smooth, and drawn up tight so conduit ends will butt in couplings, connectors, and fittings.
- C. Make bends or offsets with standard ells or field bends with an approved bender.
- D. Run conduits concealed in floor slabs, below slabs, or in walls in direct line with long sweep bends or offsets. Run exposed conduits and conduits run above lay-in ceilings parallel to and at right angles to building lines. Group multiple conduit runs in banks.

- E. Secure conduits to all boxes and cabinets with two locknuts and bushings so system will be electrically continuous from service to all outlets.
- F. Cap ends of conduits to prevent entrance of water and other foreign material during construction.
- G. Complete conduit systems before pulling conductors.
- H. Conduits shall be divided according to voltage and amperage service level. Conduits of different voltage levels shall be physically separated by the following distances unless otherwise specified on the drawings by the electrical engineer or control system supplier.
 1. Level 1 conduits shall contain low level input/output signal conductors including RTD cables, thermocouple cables, and 4-20 mA dc cables from field transmitters.
 2. Level 2 conduits shall contain all conductors for 24 volts dc power and signal.
 3. Level 3 conduits shall contain all conductors for 120 volt ac power to the PLC control cabinets, motor control circuits, field devices requiring 120-volt power, etc.
 4. Level 4 conduits shall contain all conductors for 120 volts dc control power greater than 3 amps, all 120 volts ac power greater than 20 amps, and all power circuits with voltage ratings higher than 120 volts ac (277, 480, 4160, 13,200 volts etc.). Examples include 480-volt motor feeds, 5-kV feeders, and 120-volt lighting circuit and input/output devices such as limit switches and solenoid valves.
 5. Conduits shall be physically separated from each other by the following distances:

SPACING REQUIREMENTS (IN INCHES) FOR METALLIC CONDUITS			
From Level	To Level 2	To Level 3	To Level 4
Level 1	Minimum 1"	Minimum 6"	Minimum 26"
Level 2	0"	Minimum 6"	Minimum 26"
Level 3	Minimum 6"	0"	Minimum 18"

6. Levels 1, 2, and 3 conductors shall additionally be routed away from sources of high voltage or RF radiation such as switchgear, transformers, radio transmitters, and repeaters. Minimum separation from these sources of interference shall be 5 feet.
 7. Data highway communications cable is generally considered Level 1 conductors; however, special requirements apply for routing to assure a low noise environment. Refer to electrical drawings and controls supplier requirements for special considerations before routing these conduits.
- I. Where conduits of different levels must cross, the minimum separations shall be maintained, and they shall cross at right angles.
 - J. Provide cable supports in conduits rising vertically in accordance with the National Electrical Code.
 - K. Provide nylon pull cord in all empty conduits. Steel wire not acceptable as pull wire.
 - L. Conduits that pass through floor slabs (except ground floor) shall be sealed with concrete grout. Seal around conduits or other wiring materials passing through partitions, which extend

to the underside of the slab above, and those passing through smoke partitions and fire-rated walls. Refer to appropriate details on architectural and mechanical drawings.

- M. Conduits that enter crawl space, tunnels, and basements from outside the building shall be grouted-in to prevent entry of gases, vapors, insects, or rodents to these spaces from street mains.
- N. Conduit not serving elevator equipment shall not be permitted to pass through elevator shafts or elevator equipment rooms.
- O. Where IMC conduit is installed in a cabinet, junction box, pull box, or auxiliary gutter, conductors shall be protected by an insulated bushing. Locknuts shall be installed on conduit outside and inside enclosure.
- P. In areas where enclosed and gasketed fixtures and weatherproof devices are specified, where rigid conduit enters a sheet metal enclosure, junction box and outlet box, and not terminated in a threaded hub, a steel, or malleable iron nylon insulated hub, complete with recessed sealing "O" ring or sealing locknut shall be used.
- Q. Where conduits stub up in conduit space beneath switchgear and do not connect directly to equipment enclosures, use malleable iron nylon insulated ground bushing with a lay-in lug design complete with bonding screw, Raco 1212-1296.
- R. Provide seal-off fitting in all conduits entering hazardous areas and any conduits entering a cold temperature area such as freezers and dry refrigerators.
- S. In concrete slabs, block up conduit from forms and securely fasten in place. All conduits in slabs shall have a minimum of 1-1/2 inches concrete coverage above and below.
- T. Encase in 4 inches of 1:2:4 mix concrete on all sides for all feeder conduits laid below ground outside building foundation line.
- U. Where conduits running overhead pass through building expansion joints, they shall be connected by flexible metal conduit of same size with sufficient slack to allow conduits on either side of expansion joint to move a minimum of 3 inches in any direction. Provide supports as required on each side of expansion joint, all in accordance with seismic requirements of specific area.
- V. Vertical runs of emergency system feeder conduit shall be installed in a 2-hour enclosure in accordance with applicable high rise codes.
- W. Conduits for feeders and branch circuits shall be terminated directly into paperboard enclosure without the use of pull boxes, junction boxes, wireways, or auxiliary gutters, unless the paperboard enclosure does not provide sufficient surface area for all conduits. Where such cases exist, the contractor shall notify the Engineer. In no case will splices in such boxes, wireways, etc., be permitted.
- X. Failure to route conduit through building without interfering with other equipment and construction shall not constitute a reason for an extra charge. Equipment, conduit, and fixtures

3.02 EMT

Do not use electric metallic tubing in cinder concrete or cinder fill where subject to permanent moisture unless protected on all sides by a layer of non-cinder concrete at least 2 inches thick or unless the EMT is at least 18 inches under the fill. Use of set-screw fitting is not acceptable in concrete or in fill under slab.

3.03 PVC

- A. Use threaded fittings for all connectors and adapters.
- B. Provide code sized ground conductors in all power conduit runs.
- C. Provide 1/4-inch nylon pull rope in all primary power and incoming telephone service entrance conduits.
- D. Encase all PVC conduit in reinforced concrete with a minimum of 4-inch encasement on all sides except exterior branch circuits.
- E. No PVC shall emerge from the ground or the concrete slab or encasement. PVC shall convert to galvanized rigid metal prior to its emergence.
- F. Make bends with standard ells or with an approved heat bender.

3.04 FLEXIBLE METAL CONDUIT

- A. Flexible metal conduits shall be ½-inch minimum size.
- B. Where fittings for liquid tight flexible conduit are brought into an enclosure with a knock-out, a gasket assembly, consisting of one piece "O" ring, with Buna-N sealing material shall be used. Fittings shall be made of either steel or malleable iron only, and shall have insulated throats or insulated bushings.
- C. In dry locations, where final connections to motors and other equipment may be made with flexible metal conduit, fittings shall be of steel or malleable iron only with insulated throats or insulated bushings, and shall be of wedge and screw type having an angular wedge fitting between convolutions of conduit.
- D. An additional copper ground wire shall be installed inside of flexible conduit and bonded at each end to assure continuity of ground to lighting fixtures, controls, and other utilization equipment.
- E. All recessed lighting fixtures shall be connected with flexible metallic conduit from outlet box to fixture. Rigid conduit connections to lighting fixtures are not acceptable.

- F. Install liquid tight flexible conduit in such a manner as to prevent liquids from running on the surface toward fittings.
- G. Allow sufficient slack conduit to reduce the effect of vibration.

END OF SECTION

CONDUCTORS – CONTROLS AND INSTRUMENTATION

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. All work specified in this section shall comply with the provisions of Section 16010.
- B. Provide a complete system of conductors for sensing devices, transducers, and various control components as required by the control system.
- C. All conductors shall be continuous from origin to equipment terminations without splices where possible. Where splices are required, they shall be made in splice boxes with suitable connectors.
- D. Refer to drawings for sizes and number of conductors.

PART 2 - PRODUCTS

2.01 CONDUCTORS – CONTROLS

- A. Class B stranded soft-drawn copper with 600 volt thermoplastic insulation.
- B. Size 14 AWG.
- C. Type THHN/THWN.

2.02 CONDUCTORS – INSTRUMENTATION

- A. Class B concentrically stranded copper with 300 volt PVC insulation rated for 105 degrees C.
- B. Single twisted pair or triad shielded cables as required.
- C. Overall foil shield with stranded, tinned copper drain wire.
- D. Separate communication wire for calibration.
- E. Size 18 AWG.
- F. Temperature rating: 90 degrees C.

2.03 CONDUCTORS – THERMOCOUPLE

- A. Solid thermocouple extension wire with PVC insulation (nominal 15 mils) rated for 105 degrees C.
- B. Color coded per ANSI - MC96.1 - 1982.
- C. Single twisted pair, one conductor identified, with overall aluminum/mylar shield with a tinned copper drain wire.
- D. PVC insulated copper communications wire.
- E. Size 16 AWG for runs over 100 feet - otherwise 20 AWG.
- F. Temperature rating: 90 degrees C.
- G. Thermocouple extension wire metals shall match the metals used in the thermocouples.

2.04 ACCEPTABLE MANUFACTURERS AND TYPES

- A. Use Anixter or approved equal.
- B. Control Wiring: Anixter #6G-1401.
- C. Instrumentation: Twisted Pair - Anixter #323-221-1801.
- D. Instrumentation: Twisted Triad - Anixter #323-321-1801.
- E. Thermocouple Extension: Anixter #327-221-2001 or -1601 series.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install pull boxes in circuits or feeders over 100 feet long.
- B. Make all splices or connections only at outlet, pull or junction boxes.
- C. Use powdered soapstone or pulling compound to pull conductors.
- D. Deliver all conductors to job site new and in original wrapping, package or reel.
- E. All conductors and connections shall test free of grounds, shorts and opens.
- F. Prior to pulling conductor, Contractor shall verify that thermocouple wire is compatible to the devices served.

END OF SECTION

SECTION 16120

CONDUCTORS (600 VOLT AND BELOW)

PART 1 - GENERAL

1.01 WORK INCLUDED

Provide a complete system of conductors for lighting, power, fire alarm systems, and communication systems throughout the project.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All conductors to be 98 percent conductivity copper with 600-volt minimum insulation.
- B. All interior conductors to have type THWN or THHN insulation.
- C. 600-volt insulation for conductors installed in underground raceways shall have XLP (cross-linked polyethylene) insulation/jacket.
- D. Conductors size #12 feeding interior lights and receptacles shall be solid. All other interior conductors shall be stranded.
- E. Feeders between variable frequency drivers and inverter driven motors will be shielded copper conductor designed for this duty. Conductor will be a three-conductor cable with over all jacket. A ground conductor will be provided for and close-coupled to the phase conductor. Conductor to be equal to Belden variable frequency drive cable, symmetrical design with XLPE insulation.

PART 3 - EXECUTION

- 3.01 Install pull boxes in circuits or feeders over 100 feet long or as shown on the plan sheets.
- 3.03 Make all splices or connections only at outlet or junction boxes.

END OF SECTION

MEDIUM VOLTAGE CABLE TERMINATIONS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. All work specified in this section shall comply with the provisions of Section 16010.
- B. Provide a complete system of cable terminations for medium voltage power as indicated on the drawings.
- C. Refer to drawings for sizes of conductors.
- D. This section governs the installation of cable stress cones, load break elbows, dead front "T's", and Electra.

PART 2 - PRODUCTS

2.01 STRESS CONES

Live front stress cones shall be 3M-7600 Series termination (cold shrink type) with grounding kits. Rated 5 KV or 15 KV as required. Raychem Heat Shrink type of equal rating is also acceptable.

2.02 DEADFRONT ELBOWS AND CONNECTORS

- A. Applicable Standards: The 200 Amp Loadbreak and Deadbreak elbow connectors and 630 Amp Deadbreak bolted tee connectors purchased under this specification shall comply with the following standards:
 - 1. ANSI/IEEE Standard 386: Separable Insulated Connectors for Power Distribution Systems Above 600V.
 - 2. IEEE Standard 592 (Included in the Standard Above): IEEE Standard for Exposed Semiconducting Shields on Premolded High Voltage Cable Joints and Separable Insulated Connectors.

**ANSI/IEEE 386 - 199 is the proposed revision that includes new testing to ensure the current carrying capability of the 200 ampere load break separable connectors.*

- B. Service Conditions: Modular insulated connectors shall be suitable for use under the following service conditions:
 - 1. In air, including exposure to direct sunlight.
 - 2. Intermittently or continuously submerged in water.
 - 3. Environmental temperature between -20 degrees C to 65 degrees C.

- C. Ratings:
1. Phase to phase voltage = 14.4 KV.
 2. Phase to Ground = 8.3 KV.
 3. B1L = 95 KV.
 4. Current = 200 Amp or 600 Amp as required.
- D. Manufacturers:
1. 200 Amp LB Elbow Connector, 15 KV - 36 KV: Cooper LE series, with capacitive test port, or equal.
 2. 200 Amp and 400 Amp DB Elbow Connector, 15 KV - 36 KV: Cooper DE series, with capacitive test port, or equal.
 3. 630 Amp DB Bolted Tee Connector, 24 KV - 36 KV: Cooper DT series, with capacitive test port, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in strict compliance with manufacturer requirements and industry standard.
- B. Ground units as shown on the drawings.
- C. Exercise care to keep units clean and install with neat workmanship.
- D. Test units with cable as set forth in the cable sections.

END OF SECTION

SECTION 16134

PANELBOARDS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide circuit breaker type panelboards as indicated on drawings and as specified in this section.
- B. Refer to drawings for numbers of branch circuits, their ratings, number of poles, arrangements, etc.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS/EQUIPMENT

- A. Provide panelboards by Square D, G.E., Siemens, Cutler-Hammer, or approved substitute. Square D type designations are used to indicate type and quality of panelboards.
- B. Lighting panelboards for 120/208-volts, 3-phase, 4-wire service shall be Square D type NQOD.
- C. Lighting panelboards for 277/480-volts, 3-phase, 4-wire service shall be Square D type NF.
- D. Power panelboards for 120/208-volt, and 480/277-volt, 3-phase, 4-wire service shall be Square D I-Line distribution type.
- E. Lighting and power panelboards and their associated circuit breakers shall be furnished with a short-circuit current rating greater than the available fault current shown on the panel schedules.
- F. Provide panelboards of circuit breaker, dead-front safety type, UL labeled and meeting all applicable requirements of the National Electrical Manufacturers Association.
- G. Provide panelboards with lugs (both main lugs and branch circuit lugs) suitable and UL approved for aluminum and copper 75 degree C rated conductors.
- H. Provide shunt trip and GFI breakers where indicated on panel schedule.
- I. Provide electrically isolated neutral bars.

- J. Provide separate ground bars complete with lugs or connectors on bar.
- K. Provide panel doors equipped with chrome-plated locks and catches, all keyed alike. Provide two keys for each lock. Provide fronts with adjustable indicating trim clamps.
- L. Provide thermal magnetic circuit breakers that are fully rated and temperature rated for a 40 degree C ambient. Breakers shall be quick-make, quick-break type with trip indication shown by handle position other than ON or OFF and with a common trip on all multi-pole breakers.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Ground separate ground bars to panel boxes and to the main service entrance ground bus with a code-sized grounding conductor installed in the same conduit as the phase and neutral conductors.
- B. Install all circuits which use a common neutral in accordance with the latest edition of the National Electrical Code, Article Nos. 210-4, 210-5, 215-4, and 220-4d. Balance all circuits to achieve not greater than 10% unbalanced neutral current in panel feeders.
- C. Provide six circuit breaker handle lock-on devices for each lighting paperboard for installation by the Contractor on circuits as directed by the Owner to prevent unauthorized personnel from turning off circuits to controls, unit heaters, clocks, night lights, etc. Turn the spare lock-on devices over to the Owner for his use.
- D. Provide typed directory cards mounted under plastic on the doors of all panelboards. The directories shall indicate the type of devices being served, including the space number or space names in which the devices or fixtures are located.
- E. Provide engraved Bakelite nameplates for all the circuit breakers in use on power panelboards. Indicate the device, panel, or motor being served with 1/4" high letters. Provide nameplates without engraving for the spare breakers and/or spaces. Secure all nameplates to the paperboard trim with two roundhead sheet metal screws.
- F. Provide engraved Bakelite nameplates on the visible face of all lighting and power panels indicating the panel and emergency system branch designation in 3/8" letters. Secure the nameplates with a minimum of two round-head sheet metal screws. Normal power nameplates shall be black and emergency power nameplates shall be red.
- G. Provide the Owner with seven (7) sets of final as-built drawings for the panels after delivery of the panels.

END OF SECTION

SECTION 16137

CABLE TRAYS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. All work in this section shall comply with the provisions of Section 16010 (General Electrical Provisions).
- B. Furnish and install a complete cable tray system. System shall include all straight trays, fittings and related support/accessory items as required for a complete installation.
- C. Use:
 - 1. Exposed six feet above finished grade.
 - 2. Where shown on the plan sheets.
 - 3. In dry locations, not exposed to dirty atmospheres.
 - 4. Cable tray shall not be used where exposed to physical damage.
- D. Standards:
 - 1. The cable tray shall conform to NEMA Standard VE-1. The tray installation shall be in conformance with the National Electric Code.
 - 2. If used as an equipment grounding conductor, the tray shall be as classified by Underwriters Laboratories and rated in accordance with NEC Table 318-10.

PART 2 - PRODUCTS

2.01 RACEWAY TYPE

- A. Tray Type:
 - 1. Trays shall be of the ladder, trough, solid bottom or channel type as indicated on the drawings.
 - 2. Ladder Type Tray:
 - a) Shall have required rung spacing to ensure adequate cable bearing surface for the installed conductors.
 - b) Rungs shall be of the double rung or box type and shall be free of sharp edges or corners.
 - c) Rungs shall be capable of supporting a 200 lb. concentrated load (applied to the middle six inches of width) without permanent deformation.
 - 3. Trough Type Tray:
 - a) Shall be of the closely-spaced rung type (less than four inches apart) to allow for simple entry/exit of wires and cables through the bottom of the tray without the need of special bushing or adaptors.

- b) Trough bottoms shall be capable of supporting a 200-lb. concentrated load without permanent deformation.
- 4. Solid Bottom Type Tray:
 - a) Shall offer no openings at all in the bottom of the tray.
 - b) The solid bottoms shall be of flat sheet or corrugated construction.
 - c) Solid (flat) covers shall be provided when installed outdoors.
- 5. Channel Type Tray: Shall be of one-piece construction with ventilation openings in bottom of tray.

2.02 MATERIALS/FINISH

Steel trays are to be fabricated from carbon steel per ASTM A-569, A-366 or A-526. Finish to be Hot Dip Galvanized after fabrication per ASTM A123-84.

2.02 STRENGTH

The cable tray shall be capable of carrying a uniformly distributed cable load as required on the drawings.

2.03 DIMENSIONS

Cable tray shall be 3-5/8", 4-5/8" or 6" in overall height with an interior cable loading depth of 3", 4" or 5-3/8". Widths shall be as shown on project drawings.

PART 3 - EXECUTION

3.01 CONSTRUCTION

Tray shall be of all-welded construction and utilize "C" shaped channel side rails with flanges facing inward.

3.02 SUPPORTS

Installer shall supply all clamps, clips and associated parts for a complete support system.

3.03 FITTINGS

All elbows, tees and cross fittings shall be supplied without straight tangents beyond the point of curvature. Fittings shall be supplied in 36-inch radius.

3.04 ACCESSORIES

Cable tray system shall include all related accessory items such as dropouts, end plates and barrier strips to separate services in the trays. Covers shall be furnished as required for cable protection (e.g., for vertical, riser trays as they penetrate floors, etc.).

3.05 INSTALLATION

- A. The straight sections of cable tray shall be furnished in 12-foot lengths. Shorter lengths shall be field-cut and spliced using the standard cable tray splice plate as a drilling jig (24-ft. lengths shall be used for long-span support applications).
- B. Make bends or offsets with standard ells where possible.
- C. Secure conduits to cable tray with double locknuts and bushings so system will be electrically continuous. See Supporting Devices and Hangers Section 16190.
- D. Complete all raceway systems before installing conductors.
- E. Install a continuous raceway ground in back run of cable tray. Size per NEC.

END OF SECTION

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 WORK INCLUDED

This section provides specification requirements for AC inverter type adjustable frequency, variable speed drives or herein identified as AC drives for use with NEMA A or B design, AC motors.

1.02 QUALITY ASSURANCE

- A. The AC drive and all options shall be UL listed according to Electric Industrial Control Equipment Specification UL 508C. A UL label shall be attached inside each enclosure as verification.
- B. The AC drive shall be designed, constructed and tested in accordance with NEMA, NEC, VDE, IEC standards and CSA certified.
- C. The manufacturer of the AC drive shall be a certified ISO 9002 facility.
- D. The AC drive manufacturer shall offer 24 hour a day product and application response via a nationwide network of factory certified technical support personnel.

1.03 WARRANTY

A manufacturer's warranty shall be provided on all materials and workmanship of no less than one year from the date of start-up.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Allen Bradley
- B. Cutler Hammer
- C. Square D
- D. General Electric

2.02 EQUIPMENT GUIDE SPECIFICATIONS

- A. Drives to conform to the following requirements
 1. Drive to be of the Pulse Width Modulation Type (PWM) rated for the horse power or full load current of the driven equipment.
 2. Drives to be voltage source type.
 3. Standard applications will require 6 pulse input rectifiers with 3% input line reactor, one per phase.
 4. Harmonic critical applications will require 18 pulse input rectifier without reactor.
 5. Motors located further than 25 feet from the VFD will require output filters to the motors or as required by the manufacturer.
 6. Motors located further than 100 feet from the VFD will require output isolation transformers between the motors and drive or as required by the manufacturer.
- B. Use only inverter rated motors in VFD applications unless the drives are specifically designed for a specific application by the vendor.
- C. Torque rating to be 150 % of the driven equipment.
- D. Enclosure:
 1. Indoor: NEMA 1A (NEMA 1 with Gasket)
 2. Outdoor: NEMA 3R
 3. Paint with ANSI 61 Light Gray
 4. May be included within a Motor Control Center Section

2.03 CONTROL

- A. External pilot devices shall be able to be connected to a terminal strip for starting/stopping the AC drive, speed control and displaying operating status. All control inputs and outputs will be software assignable.
- B. 2-wire or 3-wire control strategy shall be defined within the software. External relays or logic devices will not be allowed.
- C. The internal power supply incorporates an automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and not be damaged if shorted or excess current is pulled.
- D. All logic connections shall be furnished on pull-apart terminal strips.
- E. There will be two software assignable, analog inputs. The analog inputs will be software selectable and consist of the following configurations: 0-20 ma, 4-20 ma, 20-4 ma, 0-5V, 1-5V, or 0-10V.
- F. There will be four software assignable, isolated logic inputs that will be selected and assigned in the software.
- G. There will be two software assignable analog outputs that can be selected and assigned in the software. The analog output assignments shall be proportional to the following motor

characteristics: frequency, current, power, torque, voltage and thermal state. The output signal will be selectable from 0-20 ma or 4-20 ma.

- H. Two voltage-free Form C relay output contacts will be provided. One of the contacts will indicate AC drive fault status. The other contact will be user assignable.

2.04 DRIVE ISOLATION AND BYPASS CONTACTORS

- A. The AC drive shall include mechanically and electrically interlocked isolation and bypass contactors complete with Class 20 thermal overload relay, circuit breaker disconnect, control circuit transformer, AFC/OFF/BYPASS switch and TEST/NORMAL selector switch.
- B. The operator shall have full control of the bypass starter by operation of the AFC/OFF/BYPASS selector switch.
- C. In the AUTOMATIC mode of operation, the bypass contactors shall be sequenced by the 110-volt rated auto start contact provided by the user.
- D. The isolation contactor for the bypass shall be sequenced to provide motor isolation during a drive ready state of operation.
- E. A TEST/NORMAL selector switch shall provide test operation of the power converter while operating the motor in bypass.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that the location is ready to receive work and the dimensions are as indicated.
- B. Verify that power is available to the AC drives prior to installation.

3.02 PROTECTION

Before and during the installation, the AC drive equipment shall be protected from site contaminants.

3.03 INSTALLATION

- A. Installation shall be in compliance with manufacturers' instructions, drawings, and recommendations.
- B. The AC drive manufacturer shall provide a factory certified technical representative to supervise the Contractor's installation, testing and start-up of the AC drive(s) furnished under this specification for a maximum total of 1 day for each UFD type.

3.04 TRAINING

An on-site training course of two (2) training days shall be provided by a representative of the AC drive manufacturer.

3.05 WIRING PRACTICES

- A. Use metallic conduit for all drive controller wiring. Do not run control and power wiring, or output power wiring from more than one drive controller, in the same conduit.
- B. Separate metallic conduits carrying power wiring or low-level control wiring by at least 3 in. (76 mm).
- C. Separate non-metallic conduits or cable trays used to carry power wiring from metallic conduit carrying low-level control wiring by at least 12 in. (305 mm).
- D. Whenever power and control wiring cross, the metallic conduits and non-metallic conduits or trays must cross at right angles.
- E. Equip all inductive circuits near the drive (relays, contactors, solenoid valves) with noise suppressors or connect them to a separate circuit.
- F. The ferrite core included with the terminal block cover is not required for North American installations.
- G. For cable tray applications, use inverter duty rated feeder cable between drive and motor.

END OF SECTION

SUPPORTING DEVICES AND HANGERS

PART 1 - GENERAL

1.01 WORK INCLUDED

Provide a system of supporting devices and hangers to ensure secure support or bracing for conduit and electrical equipment, including safety switches, fixtures, panelboards, outlet boxes, junction boxes, cabinets, etc.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Provide appropriate supporting devices and hangers as manufactured by Erico Products, Inc., Steel City, Rayco, or approved substitute:
1. Vertical flange clamps (beam clamps).
 2. "Z" purlin clips.
 3. Conduit clips.
 4. Universal clamps (Beam clamps).
 5. Beam clamps (set screw type).
 6. Combination push-in conduit clips.
 7. Combination conduit hanger clamps.
 8. Flexible conduit clips.
 9. Special combination conduit clips.
 10. One hole steel straps.
 11. Minerallac conduit hangers.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Secure conduits to within 3' of each outlet box, junction box, cabinet, fitting, etc., and at intervals not to exceed ten feet (10') for EMT and IMC conduit and in accordance with the NEC for Rigid Steel conduit. In seismic zones, support conduits 1" and under at 6' intervals.
- B. Install clamps secured to structure for feeder and other conduits routed against the structure. Use drop rods and hangers or racks to support conduits run apart from the structure.

- C. Furnish and install suitable angle iron, channel iron or steel metal framing with accessories to support or brace electrical equipment including safety switches, fixtures, panelboards, outlet boxes, etc.
- D. Paint all supporting metal not otherwise protected, with rust inhibiting primer and then with a finish coat if appropriate to match the surrounding metal surfaces. (Prepainted or galvanized support material is not required to be painted or repainted.)
- E. Use of chains, perforated iron, bailing wire, or tie wire for supporting conduit runs will not be permitted.

END OF SECTION

EMERGENCY STANDBY ENGINE GENERATOR SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. This specification defines requirements for an emergency standby engine/generator system to be installed as per plans and specifications. System shall provide for completely automatic unattended operation, for the duration of any loss of normal utility power. System shall be capable of reaching operating range within 10 seconds of initial start signal (NFPA 99, Chapter 3). Unit shall be of a continuous standby KW/KVA capacity as required.
- B. Full service responsibility for satisfactory operation and performance of this system shall rest with Division 16 contractor supplying the emergency power system. Engine/generator to be furnished with all necessary features and options to comprise a complete operable system when installed as per manufacturers' recommendations.
- C. Unit to meet requirements of NFPA-99 and NFPA-110.
- D. Warranty to be furnished on all equipment covered by specifications for a period of one (1) year from date of Owner's acceptance of equipment. Warranty to cover all components and consist of repair and/or replacement of all parts judged defective due to faulty material or workmanship, at no charge to the Owner.
- E. Unit to be equipped for indoor or outdoor installation as required.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS/EQUIPMENT

- A. Caterpillar
- B. Cummins
- C. Kohler

2.02 ENGINE

Engine shall be full diesel, compression ignition, liquid-cooled, domestically manufactured and capable of producing the rated KW at a governed speed of 1800 rpm as specified under job site conditions. Engine to be equipped with electric starting, battery charging generator, electronic governor, fuel filters, oil filters, air cleaners, cooling system, and other equipment to provide a complete operable

system. Selling distributor shall be a factory authorized distributor of the diesel engine utilized in the standby engine generator system.

2.03 COOLING

Engine shall be cooled by plant mounted radiator with engine driven fan, jacket water pump, and fan guard.

2.04 OUTDOOR INSTALLATIONS

- A. Complete engine/generator and associated accessories shall be installed in an enclosure for outdoor installation and service. Enclosure shall be mounted directly to engine/generator base and shall be of sheet steel construction. Hinged access doors shall be provided for access to control gear and areas of unit requiring periodic maintenance and/or service. Intake and outlet louvers shall be furnished to allow proper flow of cooling and combustion air with all doors closed, but arranged to prevent entrance of rain.
- B. Mufflers shall be installed on enclosure top in a horizontal position. Discharge pipe, batteries, day tank, battery charger, control gear and water jacket heater, shall be completely installed, wired and piped prior to delivery to job site.
- C. All devices requiring AC service (day tank pump, battery charger, water jacket heater, battery heaters, etc.) shall be connected to an AC service panel installed inside the enclosure. This panel shall be mounted in an accessible location and equipped with a main breaker and branch breakers as required.
- D. AC wiring inside enclosure shall be neatly routed and enclosed in same type conduit used in building.
- E. In addition to the above devices, a duplex, grounded, 120-volt, weatherproof convenience receptacle shall be provided for maintenance, servicing and lighting. This receptacle shall be connected to an emergency circuit.

2.05 SILENCERS AND BATTERIES

- A. Furnish and install critical zone exhaust silencer. VEE-type engines shall have dual inlet, single outlet. The silencer shall be as recommended by the manufacturer for critical silent installations. Condensate trap, pet cock drain shall be installed in the silencer. A flexible section, 36 inches minimum, shall be provided between the engine exhaust manifold and the silencer. This section shall be carbon steel bellows type. All exhaust system fittings shall be flanged n.p.t. connections. The silencer shall be provided with mounting brackets for ceiling suspension. The silencer shall be installed from the equipment room ceiling in a horizontal position.
- B. Engine/generator manufacturer shall specify exhaust line size required for acceptable back pressure. Exhaust line shall be Schedule 40 pipe and shall be connected to engine manifold through seamless, flexible, carbon steel bellows-type connection. Exhaust systems installed inside structure shall be fully insulated and lines passing through walls shall pass through sleeves.

- C. Provide starting batteries capable of starting unit in time specified under installed conditions and capable of 60-seconds of engine cranking. Batteries to be installed in steel, insulated rack(s).
- D. Battery heater pads to be furnished on outdoor installations.
- E. Provide batteries of the heavy-duty, nickel cadmium type, plastic case, shipped dry with electrolyte installed at start-up. Battery cables to be sized and provided by engine/generator vendor.
- F. Provide an automatic battery charger. Charger shall operate on 120-volt input and shall be AC line compensated. Input and output shall be fused. Charger shall provide continuous taper charging and provide float and equalize function. Charger shall be in NEMA-1 cabinet and equipped with DC ammeter, DC voltmeter, high/float switch, and low DC voltage alarm relay. Minimum continuous DC output shall be 10 amperes.

2.06 FUEL TANKS

- A. Day Tank: (Required on units fed from a main tank.)
 - 1. Provide a fuel day tank. Engine/generator distributor shall specify fuel line size between fuel source and tank, as well as day tank to engine. Day tank shall be of heavy-duty steel construction, self-supporting.
 - 2. Fuel transfer pumps shall be duplex electric motor-driven, float controlled and capable of delivering fuel from source at a rate of three times full load fuel consumption. Provide check valve on pump inlet to prevent loss of prime.
 - 3. Provide manual hand pump of a size sufficient to supply adequate fuel under manual operation.
 - 4. In addition to standard fittings, day tank shall also include manual fill cap, fuel level gauge, pump test switch, drain petcock, and low fuel alarm float switch. This alarm switch shall operate annunciator "Low Level Supply."
 - 5. Day tank shall be of sufficient capacity to operate the unit at full load for not less than 2 hours.
- B. Main Fuel Tank (if required):
 - 1. If required, provide an above ground fuel storage tank as per details on drawings. Tank to bear the Underwriter's Label and the STI-P3 Labels and be installed in accordance with applicable codes regarding same. A pick-up line shall be installed to within 8" of tank bottom and equipped with check valve.
 - 2. Subbase Fuel Tank: Provide a subbase fuel tank and associated fuel line connections suitable for 48 hours of operation.

2.07 GENERATOR

- A. Alternator shall be four pole revolving field, twelve lead, reconnectable, one single bearing, brushless type for units below 2000 KVA. Larger units will be two bearing. All generators to be wound to 3/4 pitch.

- B. Entire insulation system shall be Class F or better and temperature rise to be within NEMA MG-1-22.40 for all nameplate voltages at full rated load.
- C. Rotating rectifier shall employ three phase sensing. Voltage regulation shall be plus or minus 1% from no load to full load with steady state modulation of ½%. Voltage regulator shall be static-type and a voltage adjusting rheostat to be furnished in the control panel. Voltage change to not exceed 15% upon application of full rated load with recovery to steady state conditions within 1-second. Frequency regulation by engine governor to be within 1% steady state with a maximum 2% drop, no load to full load. Generator/regulator system shall be capable of producing 250% of a full load rated current for a minimum of 10 seconds under a three phase short circuit.
- D. Provide a line circuit breaker on generator output, 3-pole, molded case; frame size shall be approximately 125% of full load capacity with trip setting at full load capacity (unless otherwise indicated on plans).
- E. Provide ground fault sensing at the generator output terminals. This sensor shall annunciate at the generator-mounted control panel and remote annunciator.

2.08 GENERATOR CONTROL PANEL

- A. Generator control panel shall be NEMA-1, dead front construction and includes following:
 1. A.C. ammeter (2%), with phase selector switch.
 2. A.C. voltmeter (2%), with phase selector switch.
 3. Frequency meter.
 4. Elapsed time meter.
 5. Panel illumination lamps.
 6. Voltage adjusting rheostat.
 7. Governor speed control switch.
 8. Automatic start/stop control (solid state, cycle crank, four cycles of 10-seconds rest).
 9. Mode selector switch for "off", "manual", "automatic", "test."
 10. Automatic engine shutdown with indicating lamps to indicate that a shut-down took place for:
 - a) "excessive engine temperature."
 - b) "low oil pressure."
 - c) "overcrank" (failed to start).
 - d) "overspeed."
 11. Red lamp to function when mode selector switch is in a position other than "automatic."
 12. Adjustable timer shall provide up to 30-minute unload running of engine after automatic transfer switch returns to normal. Factory to preset timer to 5 minutes unload time.
 13. Engine oil pressure gauge.
 14. Engine water temperature gauge.
 15. Battery charging ammeter.
 16. A sensor device, plus visual warning device with alarm horn and silence switch indicating "low fuel level", "low water temperature" and visual pre-shutdown alarms for "low oil pressure", "high water temperature", and "ground fault".

17. Generator control panel shall be shock mounted on unit unless otherwise shown on drawings.

2.09 REMOTE ANNUNCIATOR

- A. Provide solid state remote annunciator panel, storage battery powered, in compliance with ~~NFPA 99 - 1984, Section 8-2.3.5~~~~NFPA 110~~.
- B. Panel shall be mounted where shown on drawings to include indicating lamps with alarm horn and silence switch for:
 1. Low oil pressure pre-alarm (shutdown).
 2. Battery charger malfunction.
 3. Low water temperature (warning).
 4. Excessive engine temperature (shutdown).
 5. Low fuel level (main tank).
 6. Overspeed shutdown.
 7. Overcrank shutdown (failed to start).
 8. Ground fault (warning).
 9. Indicating lamps only for generator carrying load and generator running.
 10. Red lamp to indicate when mode selector switch is in a position other than "automatic".

PART 3 - EXECUTION

3.01 INSTALLATION REQUIREMENTS

- A. Entire unit shall be installed in accordance with manufacturer's recommendations.
- B. Mounting: Complete engine/generator and all mounted accessories shall be assembled on a common channel steel base. Fuel oil lines and lube oil drain shall terminate in base. Lube oil drain line shall be brought out to beyond the base to facilitate changing of the oil. Flexible fuel line sections (18" long) shall be installed between base and fuel lines. Heavy-duty, steel spring vibration isolators shall be installed between the base and mounting pad. Isolators shall be sized and located as recommended by generator manufacturer.
- C. Contractor shall provide the services of a factory-trained engineer for periodic job site visits during installation to ensure that the system is being installed in accordance with manufacturer's recommendations.
- D. Complete engine/generator system shall be tested after installation to ensure that the engine/generator, automatic transfer switch, alarm annunciators, and all other equipment function in accordance with the specifications.
- E. After Owner acceptance, Contractor and/or vendor, shall conduct a minimum 4-hour training session in operation and maintenance for Owner's personnel. After installation, a 4-hour full load test shall be conducted by the distributor's engineer. This test shall be conducted using

available building load, plus temporary load bank capacity so that full nameplate reading is utilized during test. Temporary load banks shall be furnished by generator distributor and connected by Division 16 Contractor. Test data shall be recorded and become a part of the three (3) Owners Manuals to be supplied.

- F. Contractor shall receive, store, uncrate and temporarily connect resistive type load(s) furnished by the generator supplier for full-load testing of the system. After completion of this testing, the Contractor shall disconnect, crate and load for shipment, the temporary load banks.
- G. Ground the engine generator frame and enclosure using an equipment grounding conductor sized in accordance with the NEC. Do not ground generator neutral.

END OF SECTION

UNDERGROUND DUCTS AND UTILITY STRUCTURES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. This Section includes underground conduits and ducts, duct banks, pull boxes and handholes, manholes, and other underground utility structures.
- B. Products furnished but not installed under this Section include pulling eyes, cable stanchions, cable arms, and insulators. For each manhole/handhole, furnish 1 stanchion for each 30 linear inches (750 mm) of interior floor perimeter. In addition, furnish 1 arm for each stanchion, 3 insulators for each arm, and a total of 3 pulling eyes. Furnish materials complete with associated fasteners, packaged with protective covering for storage and with identification labels clearly describing contents.

1.02 DEFINITIONS

- A. Duct: Electrical conduit and other raceway, either metallic or nonmetallic, used underground, embedded in earth or concrete.
- B. Duct Bank: 2 or more conduits or other raceway installed underground in the same trench or concrete envelope.
- C. Manhole: An underground utility structure, large enough for a person to enter, connecting with ducts to facilitate installation and maintenance of cables.

1.03 SUBMITTALS

- A. Product data for metal accessories for manholes and handholes, conduit and duct, duct bank materials, and miscellaneous components.
- B. Shop drawings showing details and design calculations for precast manholes and handholes, including reinforcing steel. Stamp drawings with seal of registered professional structural engineer.
- C. Certificate for concrete and steel used in underground precast concrete utility structures, according to ASTM C 858.
- D. Inspection report for factory inspections, according to ASTM C 1037.
- E. Field test reports indicating and interpreting test results relative to compliance with performance requirements of "Field Quality Control" Article in Part 3 of this Section.
- F. Record Documents: Show dimensioned locations of underground ducts, handholes, and manholes.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firm experienced in manufacturing underground precast concrete utility structures of types and sizes required and similar to those indicated for this Project. Firm must have a record of successful in-service performance.
- B. Comply with NFPA-70 "National Electrical Code" and ANSI C2 "National Electrical Safety Code" for components and installation.
- C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- D. Coordinate layout and installation of ducts and manholes with final arrangement of other utilities as determined in the field.
- E. Coordinate elevations of duct and duct bank entrances into manholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and ensure duct runs drain to manholes and handholes, and as approved by the Engineer.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver ducts to site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.07 EXTRA MATERIALS

- A. Furnish extra materials matching products installed, packaged with protective covering for storage and with identification labels clearly describing contents.
- B. Furnish extra cable stanchions, support arms, insulators, and associated fasteners each in quantities equal to 5 percent of quantities installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide specified products by one of the following:
 - 1. Underground Precast Concrete Utility Structures:
 - a) Precast Oldcastle.
 - b) Elmhurst-Chicago Stone Co.
 - c) Utility Vault Co.
 - d) Wausau Concrete Co.
 - 2. Frames and Covers:
 - a) Campbell Foundry Co.
 - b) McKinley Iron Works, Inc.
 - c) Neenah Foundry Co.
 - 3. Nonmetallic Ducts:
 - a) Arco Corp.
 - b) Electri-Flex Co.
 - c) Spiraduct, Inc.

2.02 CONDUIT AND DUCT

- A. PVC, Type EB Conduit: Rated for use with 90 deg C conductors under all installation conditions.
- B. PVC, Schedule 40 Conduit, direct buried without concrete.
- C. PVC Conduit and Tubing Fittings: NEMA TC 3.
- D. Plastic Utilities Duct: NEMA TC 6.
- E. Plastic Utilities Duct Fittings: NEMA TC 9; match to duct type and material.
- F. Plastic Communication Duct and Fittings: NEMA TC 10.
- G. Manufactured Bends: Not less than 36-inch (900 mm) radius.
- H. Coilable Plastic Duct: NEMA TC 12.

2.03 PULL BOXES

- A. Cast Metal Boxes: Cast aluminum, sized as indicated, with outside flanges and recessed, gasketed cover for flush mounting. Nonskid finish on cover.
- B. Cover Legend: ELECTRIC.

2.04 UNDERGROUND PRECAST CONCRETE UTILITY STRUCTURES

- A. Precast Units: Interlocking, mating sections, complete with accessory items, hardware, and features as indicated. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
- B. Design structure according to ASTM C 858.
- C. Structural Design Loading: ASTM C 857, Class A-16.
- D. Fabricate according to ASTM C 858.
- E. Joint Sealant: Continuous extrusion of asphaltic butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand the maximum hydrostatic pressures at the installation location with the ground water level at grade.
- F. Source Quality Control: Inspect structures according to ASTM C 1037.

2.05 ACCESSORIES

- A. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during concreting.
- B. Frames and Covers: Cast iron with cast-in legend ELECTRIC as appropriate. Machine cover-to-frame bearing surfaces.
- C. Sump Frame and Grate: Comply with FS RR-F-621, Type VII for frame and Type I for cover.
- D. Pulling Eyes in Walls: Eyebolt with reinforcing bar fastening insert. 2-inch (50 mm) diameter eye, 1-inch (25 mm) by 4-inch (100 mm) bolt. Working load embedded in 6-inch (150 mm), 4000 psi (27.6 MPa) concrete: 13,000 pounds minimum tension.
- E. Pulling and Lifting Irons in Floor: 7/8-inch-diameter (21 mm), hot-dipped galvanized, bent steel rod, stress relieved after forming, and fastened to reinforced rod. Exposed triangular opening. Ultimate yield strength: 40,000 pounds shear and 60,000 pounds tension.
- F. Bolting Inserts for Cable Stanchions: Flared, threaded inserts of non-corrosive, chemical resistant, nonconductive thermoplastic material; ½-inch (12 mm) internal diameter by 2-3/4 inches (68 mm) deep, flared to 1-1/4 inch (30 mm) minimum at base. Tested ultimate pull-out strength: 12,000 pounds minimum.
- G. Expansion Anchors for Installation After Concrete is Cast: Zinc-plated carbon steel wedge type with stainless-steel expander clip ½-inch (12 mm) bolt size, 5300-pound rated pull-out strength, and 6800-pound rated shear strength minimum.
- H. Cable Stanchions: Hot-rolled, hot-dipped galvanized "T" section steel, 2-1/4-inch (56 mm) size, punched with 14 holes on 1-1/2-inch (35 mm) centers for cable arm attachment.

- I. Cable Arms: 3/16-inch (5 mm) thick hot-rolled, hot-dipped galvanized sheet steel pressed to channel shape, approximately 12 inches (300 mm) wide by 14 inches (350 mm) long and arranged for secure mounting in horizontal position at any position on cable stanchions.
- J. Cable Support Insulators: High glaze, wet-process porcelain arranged for mounting on cable arms.
- K. Ground Rods: Solid copper clad steel, 3/4-inch (18 mm) diameter by 10-feet (3 m) length.
- L. Ground Wire: Stranded bare copper, No. 6 AWG minimum.
- M. Duct Sealing Compound: Non-hardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35 degrees F (1 degree C), withstands temperature of 300 degrees F (149 degrees C) without slump, and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and the common metals.

2.06 CONSTRUCTION MATERIALS

- A. Brick: Conform to ASTM C 55, concrete brick Type I, Grade N.
- B. Mortar: Conform to ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L), where packaged mix complying with ASTM C 387, Type M may be used.
- C. Concrete: Conform to Division 3 Section "Cast-In-Place Concrete" for concrete and reinforcing.
 - 1. Strength: 3000 psi (20.7 MPa) minimum 28-day compressive strength for ductbanks and 4000 psi (27.6 MPa) minimum 28-day compressive strength for manholes.
 - 2. Aggregate For Duct Encasement: 3/8-inch (10 mm) maximum size.

PART 3 – EXECUTION

3.01 APPLICATION

- A. Underground Ducts for Electrical Utility Service: Plastic conduit encased in concrete.
- B. Underground Ducts for Cable Circuits: Plastic underground conduit encased in concrete.
- C. Underground Ducts for Cable Circuits: PVC, Schedule 40 direct buried.
- D. Manholes: Underground precast concrete utility structures.
- E. Underground Ducts for Site Lighting: Plastic conduit direct buried.

3.02 EXAMINATION

Examine site to receive ducts and manholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and manholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.03 EARTHWORK

- A. Excavation and backfill in accordance with Section 02221 and governing power company.
- B. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Replace removed sod as soon as possible after backfilling is completed. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging or mulching.
- C. Restore disturbed paving in accordance with Section 02575 of these specifications.

3.04 CONDUIT AND DUCT INSTALLATION

- A. Install nonmetallic conduit and duct as indicated according to manufacturer's written instructions.
- B. Slope: Pitch ducts minimum of 4 inches per 100 feet (1:300) to drain toward manholes and away from buildings and equipment. Slope ducts from a high point in runs between 2 manholes to drain in both directions.
- C. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet (7.5 m) both horizontally and vertically at other locations.
- D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- E. Duct Entrances to Manholes: Space end bells approximately 10 inches (250 mm) on center for 5-inch (125 mm) ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.
- F. Building Entrances: Transition from underground duct to conduit 10 feet (3 m) minimum outside the building wall. Use fittings manufactured for this purpose. Follow appropriate installation instructions below.
 - 1. Concrete-Encased Ducts: Install reinforcing in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
 - 2. Waterproofed Wall and Floor Entrances: Install a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry

construction with 1 or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

- G. Concrete-Encased Nonmetallic Ducts: Support on plastic separators coordinated with duct size and required duct spacing, and install according to the following:
1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting. Do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other terminations in 1 continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (18 mm) reinforcing rod dowels extending 18 inches (450 mm) into the concrete on both sides of joint near the corners of the envelope.
 3. Reinforcing: Reinforce duct banks where they cross disturbed earth i.e., roadways and sidewalks where indicated on Drawings.
 4. Forms: Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and concrete envelope can be poured without soil inclusions, otherwise, use forms.
 5. Minimum Clearances Between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
 6. Depth: Except as otherwise indicated, install top of duct bank at least 30 inches (750 mm) below finished grade.
 7. Ladder: Manhole ladder shall not be a permanent fixture; it shall be a hook type ladder extended to bottom of structure.
- H. Stub-Ups: Use rigid steel conduit or IMC for stub-ups to equipment. For equipment mounted on outdoor concrete pads, extend steel conduit a minimum of 5 feet (1.5 m) from edge of pad. Install insulated grounding bushings on the terminations. Couple steel conduits to the ducts with adapters designed for this purpose and then encase coupling with 3 inches (75 mm) of concrete.
- I. Sealing: Provide temporary closure at terminations of ducts that are wired under this Project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi (1.03 MPa) hydrostatic pressure.
- J. Pulling Cord: Install 100-pound-test nylon cord in ducts, including spares.

3.05 UNDERGROUND UTILITY STRUCTURE INSTALLATION

- A. Elevation: Install manholes with roof top at least 15 inches (375 mm) below finished grade.
- B. Manhole depth shall be 7'-0" unless specified otherwise.
- C. Drainage: Install drains in bottom of units where indicated. Arrange to coordinate with drainage provisions indicated or specified.

- D. Access: Install cast-iron frame and cover. For manholes, use 30-inch (750 mm) cover offset to the end as close as possible except as indicated. Use 30-inch (750 mm) cover for handholes, except use 24-inch (600 mm) covers for 24-inch (600 mm) by 24-inch (600 mm) handholes. Install brick chimney to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1 inch (25 mm) above finished grade.
- E. Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least 3 days. After ducts have been connected and grouted, and prior to backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole/handhole chimneys after brick mortar has cured at least 3 days.
- F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cable and conductors and as indicated.
- G. Field-Installed Bolting Anchors: Do not drill deeper than 3-7/8 inches (96 mm) for anchor bolts installed in the field. Use a minimum of 2 anchors for each cable stanchion.
- H. Grounding: Install ground rod through floor in each structure with top protruding 4 inches (100 mm) above floor. Seal the floor opening against water penetration with waterproof non-shrink grout. Ground exposed metal components and hardware with bare copper ground conductor. Train conductors neatly around corners. Install on walls and roof using cable clamps secured with expansion anchors.
- I. Precast Concrete Underground Structure Installation: Install as indicated, according to manufacturer's written instructions and ASTM C 891.
 - 1. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.
 - 2. Support units on a level bed of crushed stone or gravel, graded from the 1-inch (25 mm) sieve to the No. 4 sieve and compacted to same density as adjacent undisturbed earth.

3.06 FIELD QUALITY CONTROL

- A. Testing: Demonstrate capability and compliance with requirements upon completion of installation of underground duct and utility structures.
 - 1. Grounding: Test manhole grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.
 - 2. Duct Integrity: Rod ducts with a mandrel 1/4 inch (6 mm) smaller in diameter than internal diameter of ducts. Where rodding indicates obstructions in ducts, remove the obstructions and retest.
 - 3. Water Tightness: Make internal inspection of manholes 3 months after completion of construction for indications of water ingress. Where leakage is noted, remove water

and seal leak sources. Re-inspect after 2 months and reseal remaining leak sources. Repeat process at 2 month intervals until leaks are corrected.

- B. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.

3.07 CLEANING

- A. Pull brush through full length of ducts. Use round bristle brush with a diameter $\frac{1}{2}$ inch (12 mm) greater than internal diameter of duct.
- B. Clean internal surfaces of manholes including sump. Remove foreign material.

END OF SECTION

UNINTERRUPTIBLE POWER SYSTEM (UPS)

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Uninterruptible Power System shall be a continuous duty, bi-polar, solid-state uninterruptible power system, designed to provide emergency power to critical loads. The unit shall provide power conditioning and power distribution at all phases of operation even during the emergency power mode. The system shall consist of a microprocessor controlled, solid state inverter, power purification system, sealed maintenance-free battery charger, sealed maintenance free batteries, monitor system, accessories and options.
- B. Modes of Operation: The UPS shall operate as a fully regulated and conditioned power system in the following modes:
 - 1. Normal Mode: The critical load shall be continuously supplied with regulated output power without battery backup power even under extreme brownout conditions (-20 percent of nominal). Line power shall be supplied to the Power Purification System and battery charger simultaneously maintaining a continuous float charge on the batteries.
 - 2. Emergency Mode: Upon failure of the commercial AC power, battery power is transferred through the inverter to the Power Purification System. There shall be no interruption of regulated and conditioned power to the critical load upon failure of restoration of the commercial AC power.
 - 3. Bypass Mode (Manual and Internal): If a problem occurs within the system due to an overload or internal failure, the manual bypass switch shall be activated to connect the commercial AC power to the Power Purification System. Thus, regulated and conditioned power is still supplied to the critical load until the problem is corrected. The bypass shall be internal to the UPS. System requiring external switchgear shall not be acceptable.
- C. Recharge: Upon restoration of the commercial AC power, a totally isolated and regulated battery charger shall recharge the battery automatically at an optimal level for maximum battery life.

1.02 REFERENCED STANDARDS

- A. ETL listed to UL 1012 and UL 478 standard.
- B. Meets IEEE-587 guide for surge withstandability.
- C. FCC Article 15, Section J, Class A.

PART 2 – PRODUCTS

2.01 UPS equipment shall be as manufactured by Controlled Power Company Series 1000, Model D or approved equal.

2.02 GENERAL SPECIFICATIONS

- A. Temperature Rise: Conservative transformer magnetic design shall limit transformer rise to 120 degrees Celsius or less.
- B. Ambient Operating Temperature: -10 to +40 degrees Celsius without derating normal mode.
- C. Storage Temperature: -20 to +50 degrees Celsius.
- D. Relative Humidity: 95 percent non-condensing.
- E. Elevation: 5,000 ft. (1500M) without derating.
- F. Audible Noise: 45 dB to 60 dB depending on KW.
- G. Isolation: Output fully isolated from input, battery and bypass.
- H. Battery Charger: Fully isolated and regulated.
- I. Power Purification System: All copper construction.
- J. Inverter Line Sync Range: +2.5 Hertz.
- K. Slew Rate: Less than 0.2 Hertz per second.

2.03 INPUT SPECIFICATION

- A. Power Rating: As required at unity P.F.
- B. Input Voltage and Interface:
 - 1. KVA: As required.
 - 2. Input Voltage: As required.
 - 3. Output Voltage: As required.
- C. Operating Input Voltage Range (Without Battery Consumption): +15 percent to -20 percent of nominal.
- D. Input Surge Capability: Per IEEE 587B.

2.04 OUTPUT SPECIFICATION

- A. Output Voltage Regulation: The output voltage will not change more than +2 percent under a change of input voltage from 120 percent to 0 percent of nominal rated input.
- B. Load Regulation: The output voltage will not change more than +2 percent with a change in load from 0 percent to 100 percent of rated load.
- C. Harmonic Distortion: Shall be less than 5 percent THD for 100 percent linear load.
- D. Fault Clearing Capacity: Will withstand a current surge of 150 percent rated load for 1,000 cycles while maintaining the output voltage to 90 percent of nominal rating.

2.05 PERFORMANCE SPECIFICATIONS

- A. Dynamic Voltage Response: Shall be to +8 percent of nominal voltage for a 10 percent to 100 percent step load within one cycle.
- B. Dynamic Voltage Recovery: Shall be five cycles to within +2 percent with load change of 0 percent to 100 percent to 10 percent.
- C. Inverter Frequency Regulation: Shall be +0.5 Hz free running.
- D. Overload Capability: Will withstand an overload current of 125 percent continuously while maintaining the output voltage to 94 percent of output voltage rating with input at nominal.
- E. Output Load Configuration: Full rated KVA can be drawn from any output voltage tap. No load balancing shall be required.
- F. Common Mode Noise Attenuation: Shall be 140 dB.
- G. Transverse Mode Noise Attenuation: Shall be 120 dB.
- H. Coupling Capacitance: 0.001 pf.
- I. Electrostatic Discharge Withstand Voltage: 25,000 volts.
- J. Input Power Factor: Is 0.9 lagging at full load and nominal input voltage.
- K. Efficiency and BTU/HR Emitted: The following table indicates the minimum efficiency and maximum allowable BTU/HR.

KW	MINIMUM EFFICIENCY	MAXIMUM BTU/HR EMITTED
2	85%	1023
2.5	86%	1193
3	87%	1466
3.5	89%	1527
5	87%	2216
6	88%	2455
8	86%	3819
9.5	87%	4211
10	85%	5115
12	87%	5320
15	89%	5626
18	90%	6138
20	90%	6820
24	90%	8184

L. MTBF: MTBF shall exceed 20,000 hours.

2.06 BATTERY SPECIFICATION

- A. Batteries: Shall mount in a fully accessible rack assembly within the main cabinet. Additional battery time is supplied in a matching cabinet and is connected by means of a quick connect connector.
- B. Battery Type: Shall be sealed, starved electrolyte maintenance free lead acid cells. Battery support time shall be provided by a 15 minute battery pack. Gelled electrolytes will not be accepted.
- C. Expected Battery Life: Shall be five year service life.
- D. Maintenance Free: There shall be no need to check the specific gravity of the electrolyte or add water.
- E. Minimum Final Discharge Voltage: Shall be 1.67 volts per cell.
- F. Nominal Float Voltage: Shall be 2.27 volts per cell.
- G. Operating Temperature:
1. Charge: -15 degrees C to 50 degrees C (5 degrees F to 122 degrees F).
 2. Discharge: -5 degrees C to 50 degrees C (-40 degrees F to 122 degrees F).
 3. Storage: -5 degrees C to 60 degrees C (-40 degrees F to 140 degrees F).
- H. Capacity: The lead acid battery shall be sized to support the inverter at rated KW at 0.8 power factor.

- I. Battery Ventilation: Batteries shall be provided with a safe low pressure venting system designed to release excess gas and reseal automatically in the event that pressure rises to a level above the normal. There shall be no excessive build-up of gas in the batteries.
- J. Battery Charger: A current limited and voltage regulated charger maintains the batteries at full charge whenever the system is operating on utility power. Current limited to 5, 10 or 20 ampere depending on charger option and not to exceed 0.25 battery/amp hour rating. Hysteresis loop cycled battery chargers will not be permitted.
- K. Battery Circuit Breaker: A manual means of disconnection and protection against short circuit shall be provided via a molded case thermo-magnetic breaker.
- L. Battery Recharge Time: Shall be no greater than 10 times the discharge time to 90% capacity.

2.07 SERVICE AND MAINTENANCE

Shall be designed for ease in servicing.

2.08 SYSTEM DESCRIPTION

- A. Power Purification System: (Regulator and Conditioner) shall receive either utility power (normal mode) or inverter power from the battery, and convert that power to clean well regulated power for the load. The output power shall be distortion free, (5% THD) regardless of the harmonic distortion on the input. Construction shall be all copper, Class H insulation and vacuum impregnated.
- B. Inverter: Shall convert the DC battery power to the Power Purification System during the normal mode of operation.
- C. Battery Charger: Shall totally isolate the current and voltage regulated battery charger to charge the batteries at a proper rate to assure maximum battery life.
- D. Circuit Breakers: Input molded case breaker and DC molded case breaker for the battery shall be provided for additional protection.
- E. Control Circuit: The control circuit shall integrate logic for continuous sensing of line voltage status. Immediate correcting action shall be instituted if abnormal conditions exist.
- F. Sentinel Monitor System: This monitor shall be standard on all UPS's, designed to indicate the system status (refer to detailed description).

2.09 MONITOR SYSTEMS

- A. System Sentinel: The standard monitor on all UPS's shall include the following:
 - 1. Line Power Present.
 - 2. Battery Charger.
 - 3. Reserve Battery Power.
 - 4. Conditioned Power Present.
 - 5. Percent Load.

6. Overload.

2.10 BATTERY POWER DESCRIPTION

- A. The Battery Power display shall be a 10 LED bar graph. When in normal operation the top LED will be lit indicating the batteries are charged to the float voltage. When the unit switches to battery power during a power interruption, the bar graph LED's proportional to the load, thus providing a visual indication of percent of reserve battery. Shut down will occur when battery voltage reaches preset minimum. The 10 percent level on the bar graph indicates shut down is imminent.
- B. Alarm Panel: The alarm panel shall provide audible/visual warning of specified fault conditions. Two membrane switches shall be located on the membrane panel. Alarm Silence will silence audible alarm (during a fault condition or when unit is on battery power). Visual alarm (LED's) remain lit until fault is cleared.

2.11 MECHANICAL CHARACTERISTICS

- A. Construction: The UPS system shall be housed in an enclosed metal cabinet(s) designed to conform to UL safety standards. Power input and output to the UPS system shall be via junction boxes with input and output cable lugs for hard wiring in lieu of flexible cables and/or receptacles.
- B. All cabinets will include casters for ease of installation and mobility and include appropriate AC and/or DC circuit breakers.
- C. Ambient Operating Temperature: 10 to 40 degrees Celsius without derating.
- D. Storage Temperature: 20 to 50 degrees Celsius, prolonged storage above 50 degrees Celsius will cause battery to deteriorate or discharge.
- E. Temperature Rise: Conservative transformer magnetic design limits transformer rise to 120 degrees Celsius or less.
- F. Relative Humidity: 95 percent non-condensing.
- G. Elevation: 5,000 feet (1500M) without derating.
- H. Audible Noise: 45 dB to 60 dB depending on KVA size of the unit.
- I. Isolation: Output fully isolated from utility and battery.
- J. Transformer: All current carrying elements are of electrical grade copper.

2.12 MONITOR SYSTEMS

- A. Standard Monitor: The standard monitor on all UPS's shall include the following:
1. Line Power: Green LED.
 2. Battery Charger: Green LED.
 3. Conditioner and Regulator - Power Purification System: Green LED.
 4. Overload Condition: Red LED.

2.13 PERCENT LOAD

The percent load display shall be a 10 segment bar graph providing visual indication proportional to the percent of load.

2.14 BATTERY POWER

The Battery Power Display shall be a 10 segment LED bar graph. When in normal operation the top LED will be lit indicating the batteries are charged to float voltage. When a power interruption occurs the LED bar graph will provide a visual indicator of the reserve battery. Shut down will occur when the battery voltage reaches a pre-set minimum of 1.67 VPC. The 10 percent level on the bar graph indicates shut down is imminent.

2.15 ALARMS

- A. The alarm panel shall provide audible/visual warning of the following conditions:
1. High temperature.
 2. Low battery warning.
 3. Battery disabled.
 4. On battery power.
 5. UPS in bypass.
 6. Manual restart required.
- B. The alarm conditions shall not shut down the UPS.

2.16 SHUT DOWN ANNUNCIATION

- A. Shut down annunciation shall provide audible/visual alarm of the following condition shut downs:
1. Low battery.
 2. Remote emergency power off.
 3. Data Guard.
 4. Overtemperature.

2.17 MEMBRANE SWITCHES

Two membrane switches shall be located on the membrane panel.

2.18 ALARM – SILENCE

Silence shall silence audible alarm (during a fault condition or when unit is on battery power). Visual alarm (LED's) shall remain lit until fault is cleared.

2.19 MANUAL RESTART

Will restart the unit if shut down conditions are cleared or reset.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide flexible conduit to and from UPS cabinet for hardwire installation.
- B. Install UPS unit in accordance with manufacturer's recommendations.
- C. Provide working clearances as required by NEC.
- D. Ground UPS enclosure with bonding jumper.
- E. Provide both primary and secondary protection by use of fuses or circuit breakers as shown on drawings.

END OF SECTION

PAD-MOUNTED TRANSFORMERS

PART 1 - GENERAL

1.01 WORK INCLUDED

This Section includes distribution transformers with medium-voltage primaries. Types of transformers specified in this Section include pad-mounted, liquid-filled transformers. Installation of pad-mounted transformers also includes construction of the concrete pad in accordance with the requirements and standard details of the governing power company.

1.02 DEFINITIONS

- A. Listed: As defined in the "National Electrical Code," Article 100.
- B. Nationally Recognized Testing Laboratory (NRTL): A testing agency qualified as defined in OSHA Regulation 1910.7.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer of medium-voltage electrical distribution equipment to perform the installation specified in this Section.
- B. Field Testing Agency Qualifications: To qualify for acceptance, the testing agency must demonstrate, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated.
- C. Comply with NFPA 70 "National Electrical Code."
- D. Comply with IEEE C2 "National Electrical Safety Code."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. General Electric Company
 - 2. ABB Power T & D Co., Inc.
 - 3. Cooper.
 - 4. Square D Co.
 - 5. Virginia Transformers

2.02 TRANSFORMERS – RATINGS

- A. Windings: Two-winding type configured as required.
- B. Voltages: Primary and secondary as required.
- C. Rating: In KVA, 3 Phase, 60 Hz to supply the connected load.
- D. Low-Sound Level Transformers: Units with a sound level rating a minimum of 3 dB less than NEMA TR 1 standard sound levels for the transformer type and rating.
- E. Windings: Copper.
- F. Impedance: ANSI C57.12.00 Standard with $\pm 7.5\%$ tolerance.
- G. Insulation Temperature Rise: 55/65 degree C rise.
- H. Basic Impulse Insulation Level (BIL) as follows:

<u>Operating Voltage</u>	<u>BIL</u>
480 V	30 KV
5 KV	60 KV
15 KV	95 KV
25 KV	150 KV

2.03 TRANSFORMERS – GENERAL

- A. Comply with IEEE C57.12.22 and C57.12.28.
- B. Insulating Liquid: Insulating liquid shall be bio-degradable, FR3 or approved equivalent.
- C. Full-Capacity Voltage Taps: Four nominal 2.5-percent taps, 2 above and 2 below rated high voltage, with externally operable tap changer for de-energized use, with position indicator.
- D. High-Voltage Arrangement: Dead-front equipped for radial or loop feed as required.
- E. Fusing: Internal Bay-O-Net fuses in series with current limiting fuses. Size to protect transformer.
- F. Surge Arresters: Distribution class, one for each primary phase. Comply with NEMA Standard LA 1 "Surge Arresters."
- G. High-Voltage Terminations and Equipment: The high voltage terminations and equipment shall be dead-front and conform to ANSI C57.12.22 requirements.
- H. 200-amp, 15-kV, feed-through 4-position switch if required.
- I. 200-amp, 15-kV, 2-position switch if required.
- J. Accessories: Provide the following accessories:

1. One-inch (25-mm) drain valve with sampling device.
2. Dial-type thermometer.
3. Liquid level gauge.
4. Pressure-vacuum gauge.
5. Pressure-Relief Device: Self-sealing with indicator.
6. Mounting provision for low-voltage current transformers and potential transformers.

2.04 FINISHES

Enclosure Coating System for Outdoor Units: Comply with IEEE Standard C57.12.28 "Pad-Mounted Equipment-Enclosure Integrity," regardless of transformer type.

2.05 SOURCE QUALITY CONTROL

- A. Factory Tests: Design and routine tests conform to the referenced standards.
- B. Factory Sound-Level Tests: Conduct sound level tests on equipment for this Project where specifying sound levels below the standard ratings.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Comply with IEEE Standard C2, "National Electrical Safety Code" and the manufacturer's written installation instructions.
- B. Identify transformers and install warning signs as appropriate.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.02 GROUNDING

Ground transformers and systems served by transformers according to Division 16 Section "Grounding" and as shown on drawings.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Arrange and pay for the services of a factory-authorized service representative to supervise the field assembly and connection of components, and the pretesting and adjustment of transformer components and accessories.
- B. Pretesting: After completing system installation, perform the following preparations for tests:
 1. Conduct insulation-resistance tests for transformers.
 2. Conduct a continuity test for windings.

3. Provide a set of Contract Drawings to the testing agency.
 4. Provide manufacturer's installation and testing instructions to the testing agency.
- C. Test Objectives: To ensure transformer installation complies with Contract Documents, is operational within industry and manufacturer's tolerances, and is suitable for energizing.
- D. Test Labeling: Upon satisfactory completion of tests for each transformer, attach a dated and signed "Satisfactory Test" label to the unit.
- E. Schedule tests and provide notification at least one week in advance of test commencement.
- F. Report: Submit a written report of observations and tests. Report defective materials and workmanship.
- G. Tests: Include the following minimum inspections and tests according to the manufacturer's instructions. For test method and data correction factors, conform to IEEE Standard Test Codes C57.12.90 for liquid-filled units, and IEEE C57.12.91 for dry-type units.
1. Inspect accessible components for cleanliness, mechanical, and electrical integrity, for presence of damage or deterioration, and to ensure removal of temporary shipping bracing. Do not proceed with tests until deficiencies are corrected.
 2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, where not available, those of UL Standards 486A and 486B.
 3. Insulation Resistance: Perform megohm meter test of primary and secondary winding-to-winding and winding-to-ground according to the following:

WINDING RATING (VOLTS)	MINIMUM TEST [VOLTS (dc)]	MINIMUM RESISTANCE DRY TYPE	INSULATION (MEGOHMS) LIQUID FILLED
0 - 600	1,000	500	100
5,000 - 35,000	5,000	25,000	5,000

- a) *Duration of Each Test: 10 minutes.*
 - b) *Temperature Correction: Correct results for test temperature deviation from 20 deg C standard.*
4. Turns Ratio: Measure between windings at each tap setting. Measured ratios deviating more than 0.5 percent from the calculated ratio or the measured ratio for adjacent coil are not acceptable.
 5. Winding Resistance: Measure for winding at nominal tap setting. Measured resistance deviating more than 1 percent from that of adjacent winding is not acceptable.
 6. Liquid-Filled Transformer Insulation Power Factor Test: Determine overall dielectric loss and power factor for winding insulation. Limit test voltage to the line-to-ground voltage of the winding being tested.
 7. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.04 ADJUSTING

- A. After completing installation and cleaning, touch up scratches and mars on finish to match original finish.
- B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout the normal operating cycle of the facility. Record voltages and tap settings to submit with test results.

3.05 DEMONSTRATION

- A. Training: Arrange and pay for the services of a factory-authorized service representative to demonstrate transformers and accessories and train Owner's staff. Include a minimum of 8 hours of training in operation and maintenance. Provide both classroom training and hands-on equipment operation covering the following:
 - 1. Safety precautions.
 - 2. Features and construction of project transformers and accessories.
 - 3. Routine inspection, test and maintenance procedures.
 - 4. Routine cleaning.
 - 5. Features, operation, and maintenance of integral disconnect and protective devices.
 - 6. Interpretation of readings of indicating and alarm devices.
 - 7. Fuse selection.
 - 8. Protective relay setting considerations.
 - 9. Features, operation and maintenance of separable insulated connector system.
 - 10. Tap-changing procedures.
- B. Schedule training with at least 7 days advance notice.

3.06 ADDITIONAL EQUIPMENT

- A. Provide lightning arresters on each incoming primary phase.
- B. Provide one spare set of fuses for each type of the internally fused units.

END OF SECTION

MEDIUM VOLTAGE METAL ENCLOSED SWITCHES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. All work specified in this section shall comply with the provisions of Section 16010.
- B. The outdoor padmounted gear shall consist of a single self-supporting enclosure, containing three-phase gang operated interrupter switches and three-phase sets of single pole hook stick operable fuses with the necessary accessory components, all completely factory assembled and operationally checked.
- C. To ensure a completely coordinated design, the switchgear shall be integrally designed and produced by the manufacturer of the basic switching equipment.
- D. Certification of Ratings:
 - 1. The manufacturer shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated padmount gear assembly as rated.
 - 2. The manufacturer shall furnish certification of ratings of the basic switch and fuse components and/or the integrated padmounted gear assembly consisting of the switch and fuse components in combination with the enclosure. This certification of the integrated unit shall include testing the switchgear to the fault close requirements of the specification to assure the bus support system and components are adequate.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Cutler Hammer
- B. S&C
- C. General Electric

2.02 EQUIPMENT GUIDE SPECIFICATIONS

- A. Main Bus will be tin plated non-insulated bus copper or aluminum.
 - 1. Current rating for the switchgear Bus will be calculated on the connected load and any expected future loads.
 - 2. Electrical Designer shall perform fault current calculations based on utility available fault current and specify bracing to meet or exceed the calculated value.

3. For equipment that must be maintained while energized, Electrical Designer will perform Arc Flash analysis as required by NFPA-70E or task the Contractor to do so and affix required labels to the face of the enclosure.
- B. Main switch will be load break switch fusible or non-fused as required by the application meeting UL and ANSI requirements.
- C. Provide main switch where required by Code
1. Lightning arresters will be provided on the main incoming lines.
 - a) Distribution class arresters rated for the operating voltage and system configuration.
 - b) Install arresters with adequate clearance from incoming lines.
 2. If required, provide revenue grade meter on the main to monitor the following:
 - a) Total Demand:
 - b) Total Usage: KWH
 - c) System Power Factor
- D. Voltage will be specified to match system requirements.
1. Ungrounded systems are not allowed.
 2. Voltage reference provided by solidly grounded systems is preferred.
 3. Absence of a ground reference will be compensated for by providing a high or low resistance ground and protective relaying.
- E. Basic Impulse Level (BIL) for the Switchgear construction will conform to the following:
- | <u>Operating Voltage</u> | <u>BIL</u> |
|--------------------------|------------|
| 5 KV | 60 KV |
| 15 KV | 95 KV |
| 25 KV | 150 KV |
- F. Feeder Protection:
1. Provide three phase fusible disconnects.
 2. Provide fault locators on each phase.
 3. Metering
 - a) KW Demand
 - b) KWH Usage
 - c) Power Factor
- G. Enclosure:
1. Enclosure to be pad mounted or free-standing as required by the application.
 2. Provide view ports to allow “switch-open status” to be verified without exposure to the energized components.
 3. Indoor: NEMA 1A (NEMA 1 with Gasket)
 4. Outdoor: NEMA 3R
 5. Paint with ANSI 61 Light Gray
 6. Provide anti-condensation heater units in each section. Units to be thermostatically controlled and powered from a remote source.

2.03 LABELS

- A. Provide phenolic labels with ¼" high white letters on black background.
- B. Identify equipment controlled and one line designation.

2.04 LABELING

- A. Warning Signs:
 - 1. All external doors shall be provided with NEMA approved "WARNING - HAZARDOUS VOLTAGE INSIDE - KEEP OUT" signs.
 - 2. The inside of each door and each of the front insulating barriers shall be provided with NEMA approved "DANGER - HAZARDOUS VOLTAGE - KEEP OUT" signs.
- B. Rating Nameplates and Connection Diagrams:
 - 1. The outside of both the front and back shall be provided with nameplates indicating the manufacturer's name, catalog number, and model number.
 - 2. The inside of each door shall be provided with a ratings label indicating the following: Voltage ratings; main bus continuous rating; short-circuit ratings (amperes, RMS symmetrical and MVA three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings including duty-cycle fault-closing capability; and interrupter switch ratings, including duty-cycle fault closing capability and amperes, short-time, RMS (momentary, asymmetrical and one-second, symmetrical).
 - 3. A three-line connection diagram showing interrupter switches, fuses with integral load interrupter, and bus along with the manufacturer's model number shall be provided on the inside of the front and rear doors, and on the inside of each switch operating hub access cover.

2.05 AUXILIARIES

- A. End fittings or holders, and fuse units or refill units for original installation, as well as one spare fuse unit or refill unit for each fuse mounting, shall be furnished.
- B. A fuse handling tool as recommended by the fuse manufacturer shall be furnished.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Unit to be bolted to an appropriately sized concrete pad.
- B. The Contractor shall encircle the pad with a ground grid 18 inches below final grade and 18 inches horizontally from the edge of the switchgear pad as shown on the drawings. At each corner of the pad and 5'-8" horizontally from the corner, the Contractor shall drive a 3/4" X 10' copper clad ground rod to a depth where the rod top is 18" below final grade. Each of the four

ground rods shall be thermally welded to the encircling ground grid. A ground wire shall be thermally bonded to each rod and extended 18" below grade to the ground lug inside the switch. Ground wire size shall be #6 bare copper minimum.

- C. The Contractor shall stub out appropriately sized conduits for each switch. Main compartment shall contain three five-inch conduits, minimum, and fusible switch compartments shall contain two four-inch conduits, minimum.
- D. Final field test and trip settings shall be made by factory representatives.

3.02 FINAL TEST AND ACCEPTANCE

- A. Contractor shall perform high potential test on all cable and terminations. (WARNING: Terminations cannot be high voltage tested while attached to the switch.)
- B. Switches shall be shown to be operational.
- C. Apply touch-up paint to all abrasions.
- D. Clean all components of dirt, grease and construction debris.

END OF SECTION

MEDIUM VOLTAGE METAL CLAD SWITCHGEAR

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. All work specified in this section shall comply with the provisions of Section 16010.
- B. The main switchgear shall be 13.2 KV, 3-phase, 4-wire system, impedance grounded, 60 hertz.
- C. Furnish and install metal-clad switchgear as described in this specification and as detailed on the plan sheets.
- D. The contractor shall be responsible for the erection, installation and start-up of the equipment covered by the specifications and plans.
- E. The metal-clad switchgear and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of ANSI, NEMA and IEEE including, but not limited to, ANSI 37.20, NEMA SG-4 and SG-5.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Cutler Hammer
- B. Square D
- C. General Electric

2.02 EQUIPMENT GUIDE SPECIFICATIONS

- A. Main Bus shall be tin plated insulated bus copper.
 - 1. Current rating for the switchgear bus will be calculated on the connected load and any expected future loads.
 - 2. Electrical Designer will perform fault current calculations based on utility available fault current and specify bracing to meet or exceed the calculated value.
 - 3. For equipment that must be maintained while energized, Electrical Designer will perform Arc Flash analysis as required by NFPA-70E or task the Contractor to do so and affix required labels to the face of the MCC.
 - 4. Provide Bus Differential protection (ANSI 87) including all main breakers, main bus, tie breaker and feeder breakers. Where the main bus is divided with tie breakers the

switchgear will include multiple differential zones to prevent loss of the entire line up due to a single bus fault.

- B. Main and feeder breakers shall be vacuum type, metal clad, draw out circuit breakers meeting UL and ANSI requirements. All breakers will be provided with the following:
1. Remote racking device to allow breaker extraction from a safe operating location with the breaker door closed.
 2. Protective relaying except in special circumstances where main and tie breakers will not coordinate and the breakers are grouped in a common differential protective zone.
- C. Ground and Test Device: Provide a ground and test device for each lineup where feeder or service cables cannot be accessed except through the breaker compartment for testing.
- D. Provide Main Metal Clad breaker where required by Code
1. Lightning arresters will be provided on the main incoming lines
 - a) Distribution class arresters rated for the operating voltage and system configuration.
 - b) Install arresters with adequate clearance from incoming lines.
 2. Provide revenue grade meter on each main to monitor the following:
 - a) Total Demand: KW
 - b) Total Usage: KWH
 - c) System Power Factor
- E. Voltage will be specified to match system requirements
1. Ungrounded systems are not allowed.
 2. Voltage reference provided by solidly grounded systems is preferred
 3. Absence of a ground reference will be compensated for by providing a high or low resistance ground and protective relaying.
- F. Basic Impulse Level (BIL) for the Switchgear construction will conform to the following:
- | <u>Operating Voltage</u> | <u>BIL</u> |
|--------------------------|------------|
| 5 KV | 60 KV |
| 15 KV | 95 KV |
| 25 KV | 150 KV |
- G. Feeder and Main Protection:
1. Provide three phase microprocessor based protection with the following minimum features.
 - a) ANSI 87: Bus differential protection
 - b) ANSI 27/59: Under / Over Voltage Protection.
 - c) ANSI 81 o/u: Under / Over Frequency Protection
 - d) ANSI 46: Negative Sequence Current Protection
 - e) ANSI 50 / 51 Instantaneous / Time Overcurrent Protection (Note: May not be required on Main and Tie breakers if coordination is not practical and if they are included in the same differential zone with feeders provided with protective relaying)
 - f) ANSI 50 / 51G Instantaneous / Time Ground Overcurrent Protection. (Note: May not be required on Main and Tie breakers if coordination is not practical)

and are included in the same differential zone with feeders provided with protective relaying)

- g) Phase temperature from motor mounted RTD inputs.
- 2. Display
 - a) Relay will display set points and parameters on the front screen of the relay, flush mounted in the front door of the starter
 - b) Voltage displays: Average and each
 - c) Current displays: Average and each phase
- 3. Metering
 - a) KW
 - b) KWH Usage
 - c) Power Factor
- 4. Programming: will be by laptop computer through RS Port in front of relay. Program access will be password protected.
- 5. Each line up will be provided with a satellite time link system to automatically set the time on the protective relaying. Time is to be reset hourly.

H. Enclosure:

- 1. Indoor: NEMA 1A (NEMA 1 with Gasket)
- 2. Outdoor: NEMA 3R
- 3. Paint with ANSI 61 Light Gray
- 4. Indoor and outdoor enclosures will be provided with rear and front access hinged doors with lockable "T" handles. All handles will be keyed alike.
- 5. Provide anti-condensation heater units in each section. Units to be thermostatically controlled and powered from a remote source.

I. Control Power

- 1. Control power will be provided by a 125 Volt battery system with regulated trickle charger.
- 2. Battery system will be rated to power the control system for 8 hours without recharging.
- 3. Individual sections will be powered from a control distribution panel provided with the charging system.

2.03 LABELS

- A. Provide phenolic labels with ¼" high white letters on black background.
- B. Identify equipment controlled and one line designation.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Bus: The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. A set of 1,200 ampere copper insulated main buses shall have provisions for the addition of future units.
- B. All doors, hinged bolted panels, and screen doors giving access to high-voltage components or buswork to be provided with a "Danger - High Voltage" sign.
- C. The integrated switchgear assembly to be provided with a nameplate indicating the manufacturer's drawing number and the following ratings: voltage (kV nominal, maximum design, and BIL), short-circuit rating - interrupting, momentary, and fault closing (MVA, 3 phase symmetrical). In addition, each bay to bear a nameplate indicating continuous and interrupting ratings of the circuit breaker in amps.
- D. Each unit to have a label on the outside stating the equipment being served.
- E. Accessories: The switchgear manufacturer shall furnish accessories for test, inspection, maintenance and operation, including:
 - 1. Maintenance tool for manually charging the breaker closing spring and manually opening the shutter.
 - 2. Levering crank for moving the breaker between test and connected positions.
 - 3. Test jumper for electrically operating the breaker while out of its compartment.
 - 4. Breaker lifting yoke used for attachment to breaker for lifting breaker on or off compartment.
 - 5. "Dockable" transport dolly for moving breaker outside its compartment.
 - 6. Set of rail extensions and rail clamps per each vertical section.
 - 7. Set of test plugs for use with Flexitest relays and meters.
 - 8. Remote racking device.
 - 9. Test cabinet for testing electrically operated breakers outside housing.
 - 10. Mobile lift for lifting the breaker on or off the rails.
- F. Fuses: The switchgear manufacturer shall furnish a complete set of spare fuses of each size installed in the switchgear including potential transformer primary and secondary fuses, control power transformer primary and secondary fuses, and 230 volt control circuit fuses.
- G. Documentation: The contractor shall supply six (6) sets of documentation on all equipment supplied under this contract. The documentation will include the following:
 - 1. Device Summary.
 - 2. Elementary diagram (power and control circuits showing each wire and terminal point).
 - 3. Connection diagram showing physical location of devices and wiring connection points.
 - 4. Interconnection diagram showing inter-unit wiring.
 - 5. Arrangement drawing including one-line diagram, front view, and floor plan.

6. Complete relay data sheets indicating settings and test data.
- H. Services: The contractor shall provide a field service engineer or factory representative from the switchgear manufacturer for a minimum of four (4) days on two separate occasions for check-out and unit start-up.

END OF SECTION

CIRCUIT BREAKER DISTRIBUTION SWITCHBOARD

PART 1 - GENERAL

1.01 WORK INCLUDED

Provide service entrance distribution switchgear as herein specified and shown on the associated electrical drawings. Switchboard to meet Underwriters' Laboratories enclosure requirements.

PART 2 - PRODUCTS

2.01 APPLICATION

- A. For large electrical services 1000 amps and larger.
- B. Heavy duty electrical service not requiring critical energized maintenance, as outlined above, and insulated case breakers in non-draw-out- switchboards.

2.02 ACCEPTABLE MANUFACTURERS

- A. Cutler Hammer
- B. Square D
- C. General Electric

2.03 EQUIPMENT GUIDE SPECIFICATIONS

- A. Main Bus shall be tin plated insulated bus copper.
 - 1. Current rating for the switchboard bus will be calculated on the connected load and any expected future loads.
 - 2. Electrical Designer will perform fault current calculations based on utility available fault current and specify bracing to meet or exceed the calculated value.
 - 3. For equipment that must be maintained while energized, Electrical Designer will perform Arc Flash analysis as required by NFPA-70E or task the Contractor to do so and affix required labels to the face of the MCC.
- B. Main Breakers and feeder breakers 1200 amps and above will be insulated case breaker of non-draw-out construction.
 - 1. Provide revenue grade meter on each main to monitor the following:
 - a) Total Demand: KW
 - b) Total Usage: KWH
 - c) System Power Factor

- C. Feeder breakers less than 1200 amps will be molded case circuit breakers meeting UL and ANSI requirements.
- D. Voltage will be specified to match system requirements
 - 1. Ungrounded systems are not allowed.
 - 2. Voltage reference provided by solidly grounded systems is preferred.
 - 3. Absence of a ground reference will be compensated for by providing a high or low resistance ground and protective relaying.
- E. Insulated Case Breaker Digital Electronic Trip Unit
 - 1. Provide three phase electronic trip units with ground fault protection.
 - 2. Interchangeable rating plugs.
 - 3. Adjustable Long time pickup and delay settings.
 - 4. Adjustable Short time pickup and delay settings.
 - 5. Adjustable ground fault pickup and delay settings.
 - 6. Adjustable instantaneous pickup.
- F. Feeder Protection:
 - 1. Provide three phase standard trip breakers.
 - 2. Molded case (80% rated) circuit breaker with thermal-magnetic trip.
- G. Enclosure:
 - 1. Indoor: NEMA 1A (NEMA 1 with Gasket)
 - 2. Outdoor: NEMA 3R
 - 3. Paint with ANSI 61 Light Gray
 - 4. Indoor and outdoor enclosures will be provided with rear and front access hinged doors with lockable "T" handles. All handles will be keyed alike.
 - 5. For outdoor enclosures, provide anti-condensation heater units in each section. Units to be thermostatically controlled and powered from a remote source

2.04 LABELS

- A. Provide phenolic labels with ¼" high white letters on black background.
- B. Identify equipment controlled and one line designation.

2.05 METERING

- A. Provide full function electronic metering. Meter to provide true RMS metering, including voltage line-to-line to ground, amperage, wattage, volt-amps, power factor, frequency, watt-hour demand.
- B. If required, provide separate metering compartment for metering equipment, provided by local power company.

2.06 METERING TRANSFORMERS

- A. All instrument transformers shall be UL listed and classified as indicated on drawings.
- B. Current transformers shall be as shown on drawings with burden and accuracy to support connected meters and relays as required by ANSI/IEEE C57.13.
- C. Potential transformers shall be as shown on drawings with burden and accuracy to support connected meters and relays as required by ANSI/IEEE C57.13.

2.07 FINISH

- A. All steel surfaces shall be chemically cleaned prior to painting.
- B. Exterior paint color shall be Light Gray (ANSI 61) over phosphate-type rust inhibitor.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. The following procedures shall be performed by the Contractor.
 - 1. Examine installation area to assure there is enough clearance to install switchboard.
 - 2. Check concrete pads for uniformity and level surface.
 - 3. Verify that switchboards are ready to install.
 - 4. Verify field measurements are as shown on drawings.
 - 5. Verify that required utilities are available, in proper location and ready for use.
 - 6. Beginning of installation means installer accepts conditions.

3.02 INSTALLATION REQUIREMENTS

- A. Install per manufacturer's instructions.
- B. Identify with Bakelite nameplates (with letters a minimum of 3/8" high) every switch, circuit breaker, ground fault system test panels, relays, etc., and other items. Circuit identification shall include panelboard or motor being served. Spares or spaces only shall have nameplates with no engraving. Nameplates shall be secured to switchboard with two sheet metal screws.
- C. As-built shop drawings shall become a part of final brochures.

END OF SECTION

LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 WORK INCLUDED

Provide a motor control center as herein specified and as scheduled on the electrical drawings.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Allen Bradley
- B. Cutler Hammer
- C. Square D
- D. General Electric

2.02 EQUIPMENT GUIDE SPECIFICATIONS

- A. Main Bus shall be tin plated copper bus.
 - 1. MCC wiring shall be Class I, Type B.
 - 2. Current rating for the MCC Bus will be calculated on the connected load and any expected future loads.
 - 3. Electrical Designer will perform fault current calculations based on utility available fault current and specify bracing to meet or exceed the calculated value.
 - 4. For equipment that must be maintained while energized, Electrical Designer will perform Arc Flash analysis as required by NFPA-70E or task the Contractor to do so and affix required labels to the face of the MCC.
- B. Main Circuit Breaker:
 - 1. Provide revenue grade meter on each main to monitor the following:
 - a) Total Demand: KW
 - b) Total Usage: KWH
 - c) System Power Factor
 - 2. MCC Main will be equipped with electronic trip, with phase and ground fault protection.
- C. Voltage will be specified to match system requirements.
 - 1. Ungrounded systems are not allowed.
 - 2. Voltage reference provided by solidly grounded systems is preferred.
 - 3. Absence of a ground reference will be compensated for by providing a high or low resistance ground and protective relaying.

- D. Main Lugs (where required): Main lugs shall be supplied with motor control center with adequate capacity to receive cables as indicated on drawings. Main lugs shall be copper mechanical type.
- E. Neutral Lugs (where required): Motor Control Center shall be equipped with neutral landing lug(s) for 3-phase, 4-wire requirements. Lug(s) shall receive the quantity and size of main incoming neutral conductors as indicated on drawings.
- F. Bussing:
1. Power Bus: Power shall be distributed to all sections by a main horizontal bus as rated per drawings. Distribution from the horizontal bus to each vertical section shall be by means of a vertical bus of adequate capacity for loads indicated. All power bussing and connectors shall be tin-plated copper.
 2. Ground Bus: Motor Control Center shall be equipped with a separate horizontal copper ground bus that runs the entire length of the motor control center. The horizontal ground bus shall be supplied with mechanical lugs sufficient to terminate main incoming ground conductors as indicated on drawings. Each vertical section will contain a copper vertical ground bus connected to the horizontal ground bus. This vertical ground bus will be installed so the plug-on units engage the ground bus prior to engagement of the power stabs, and will disengage only after the power stabs are disconnected upon removal of the plug-on unit. The vertical and horizontal ground bus assembly shall be ground to the enclosure.
 3. Neutral Bus: A neutral bus shall be provided which runs the entire length of the motor control center. The neutral bus shall be of the same material, rating and plating as the main bus. Holes shall be provided in the neutral bus in each vertical section to accommodate customer load neutral wire connections.
- G. Basic Impulse Level (BIL) for the MCC construction will conform to the following:
- | <u>Operating Voltage</u> | <u>BIL</u> |
|--------------------------|------------|
| 480 Volts | 30 KV |
- H. Contactors will be sized for the horse power and voltage rating or the full load current of the motor.
- I. Provide each Contactor with an isolating switch with external lockable disconnect.
- J. Circuit Breakers: Feeder breakers shall be of the molded case type.
- K. Motor Protection:
1. Provide three phase Motor Circuit Protectors with external lockable operators in each bucket.
 2. Overload Protection
 - a) For standard installations, supply eutectic alloy class-20 motor overload relays with external reset operator.
 - b) For special applications, including remote located motors, submersible motors, etc., provide ambient compensated IEC bimetallic strip overloads with mechanical current comparison or electronic overload relay units.
 - c) Special applications requiring class-10 or 30 protection will be equipped with electronic ambient compensated overload relay units.

3. Pilot devices: each starter will be provided with the following:
 - a) Enclosure door mounted Run (Green) light.
 - b) Enclosure door mounted Stop (Red) light.
 - c) Hand-off-Automatic selection switch or start/stop push buttons as required (Note: this will not be required where equipment damage or injury is at risk from improper operation).
 4. Auxiliary
- L. Enclosure:
1. Indoor: NEMA 1A (NEMA 1 with Gasket)
 2. Outdoor: NEMA 3R with rodent barriers, fluorescent lights, GFI convenience receptacle, and thermostatically controlled strip heaters.
 3. Paint with ANSI 61 Light Gray
- M. Provide horse power rated capacitors to correct system power factor. Capacitors to be mounted in the motor starter section. Do not mix variable frequency drives with power factor correction capacitors in a common enclosure.

2.03 LABELS

- A. Provide phenolic labels with ¼" high white letters on black background.
- B. Identify equipment controlled and one line designation.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. All units shall be identified with permanent type engraved Bakelite nameplates on face of units showing motor or equipment being served. Bakelite nameplates shall be fastened with two round head screws. All terminal blocks, relays, starters, timers, etc., shall be identified internally with designation as shown on drawings.
- B. Unit to be stored in a dry location.
- C. Torque all cable lugs and bus connections to assure tight fit.
- D. Once energized, check bus with IR monitoring camera and repair any hot spots.
- E. Set all overload relays and mep per NEC based on actual run currents measured in the field.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 - GENERAL

1.01 WORK INCLUDED

The entire system of raceways and equipment shall be grounded in accordance with Article No. 250 and No. 517 of latest edition of National Electrical Code and any local regulation or governing authority.

PART 2 - PRODUCTS

- 2.01 Main service disconnect means shall be bonded to street side of first flange or coupling of incoming main water line serving project with heavy-duty ground clamp in accordance with Article 250.104 of N.E.C. The bonding jumper shall be sized in accordance with Table 250.66 of N.E.C. An additional ground wire of same size shall be run to a tripod grounding rod system driven in ground outside foundation of building. This system shall consist of three 3/4" x 10' copperweld ground rods driven in ground in an equilateral triangular configuration with a minimum of 15' spacing between each. Connection of each ground rod to one another shall be made using a conductor of same size as being run for main service ground. Building steel shall be connected to ground bus on main service with a conductor the same as required on the service. This ground will be in addition to the previously specified grounds.
- 2.02 Ground Clamps: OZ Electrical Manufacturing Company, Steel City, Appleton, or approved substitute.
- 2.03 Feeder circuits to panels, motor control centers, etc., shall have a separate green grounding conductor in conduit sized in accordance with Table 250.122 of N.E.C.
- 2.04 All branch circuits shall have a separate green grounding conductor installed in same conduit as phase and neutral conductor from panel ground bus to device. The grounding conductor shall be sized in accordance with Table 250.122 of N.E.C.
- 2.05 Flexible conduit will not be approved as achieving continuity of ground. All flexible conduit shall have a jumper wire sized to ampacity of branch breaker and shall be connected to conduit system on both ends; this applies to fixtures, motors, controls, etc.
- 2.06 All PVC conduit shall have separate ground wire installed in accordance with Tables 250-94 and 250-95 of N.E.C.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Effectively bond all grounding conductors to grounding electrodes, equipment enclosures and ground busses.
- B. Provide a shunt path around main water meter by bonding around both sides of meter to assure continuity.
- C. Locate all grounding attachments away from areas subject to physical damage. Provide protective covering as required.
- D. Clean all non-conductive surfaces on equipment to be grounded, to assure good electrical continuity.
- E. Ground on main service shall be tested to obtain no greater than 10 ohms using test equipment similar to a "Biddle" test. Test data shall be submitted to Engineer for review and such test data shall become a part of the final brochure.

END OF SECTION

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. All work specified in this section shall comply with the provisions of Section 16010.
- B. Provide dry type transformer as shown on transformer schedules on drawings.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Transformers shall be as manufactured by Square D, G.E., Cutler-Hammer, or approved substitute.

2.02 EQUIPMENT REQUIREMENTS

- A. Single-phase and three-phase general purpose dry type transformers shall be equal to Hevi-Duty Electrical Class 1100 and Class 1200 respectively, be of the two-winding type, self-cooled, with ratings (KVA) as indicated on the drawings. Transformers shall be built in accordance with applicable NEMA, ANSI, IEEE, OSHA, UL standards, and regulations on listings.
- B. Transformers shall contain copper windings. Aluminum not allowed.
- C. Sound levels shall not exceed the following ranges:
 - 1. 0-9 KVA: 40 db.
 - 2. 10-50 KVA: 45 db.
 - 3. 51-150 KVA: 50 db.
 - 4. 151-300 KVA: 55 db.
 - 5. 301-500 KVA: 60 db.
 - 6. 501-700 KVA: 62 db.
- D. Transformers with single phase ratings through 10 KVA shall have a voltage ratio of 240/480 volts primary-120/240 volts secondary with a maximum temperature rise of 115 degrees C at full load rating for the non-ventilated type, suitable for indoor or outdoor use.
- E. Transformers with three phase ratings through 9 KVA shall have a voltage ratio as indicated on drawings. Provide four 2-1/2% full capacity voltage adjusting taps, 2 above and 2 below primary rated voltage. Maximum full load temperature rise shall be 115 degrees C for the non-ventilated, HARDSHELL, encapsulated type, suitable for indoor or outdoor use.

- F. Transformers shall have voltage ratios as indicated on drawings. Transformers between 15 KVA and 300 KVA to be provided with six (6) 2-1/2% full capacity taps--two above and four below primary rated voltage.
- G. Transformer core shall be of low loss type, high quality, grain oriented steel. Core clamping members shall cover a minimum of 90% of the top and bottom core yoke laminations. Vertical framing members shall be contained within the insulated coil form to minimize external flux path.
- H. Coils shall be wound of electrical grade, edge-conditioned aluminum strip on preformed rigid coil base, and shall be provided with corrugated aluminum positive spacing air duct forms, to increase air circulation and reduce hot spot temperature rise. Each coil to have a final protective outer wrap of electrical insulating material. Coils with exposed magnet wire will not be acceptable. Coil leads shall be terminated to suitable solderless lugs (thru 75 KVA), fully approved for use with either copper or aluminum cable and located on a solidly-braced, insulated terminal board.
- I. Immediately prior to initial varnish impregnation, entire core and coil assembly to be thoroughly dried in a preheat cycle, and then thoroughly baked to ensure that all volatiles have been driven off in process. Core and coil assembly to be internally isolated from enclosure through use of an effective vibration dampening system.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide flexible conduit to and from transformer.
- B. Install transformers in accordance with manufacturer's recommendations.
- C. Provide trapeze type hangers for transformers supported from the structure or mount on the floor as shown on the drawings. Floor mounted transformers shall be securely anchored to a 4" reinforced concrete housekeeping pad. Provide working clearances as required by NEC.
- D. Ground secondary neutral of all transformers to grounding conductor in primary feeder and to building steel or other approved electrode using grounding electrode conductor sized in accordance with NEC. Ground transformer enclosure with bonding jumper.
- E. Provide both primary and secondary protection by use of fuses or circuit breakers as shown on drawings.

END OF SECTION

SECTION 16505

HEAT TRACING CABLE

PART 1 - GENERAL

1.01 WORK INCLUDED

Furnish a complete Factory Mutual Approved SYSTEM of pipe heating cable for freeze prevention in hazardous (classified) areas complete with components, installation accessories and controls and installed in strict accordance with NFPA 70 and NEC 1990 Section 500-5(a) of the NATIONAL ELECTRIC CODE.

PART 2 - PRODUCTS

- 2.01 The heating cable shall consist of two (2) 14 AWG Nickel-coated-copper bus wires wrapped in a radiation-crosslinked conductive fiber core capable of regulating its power output in response to temperature changes all along its length. The heating cable shall be covered with a radiation-crosslinked modified polyolefin dielectric jacket, a tinned copper shield and fluoropolymer outer jacket capable of withstanding exposure to chemicals, solvents and hydrocarbons and exposure to temperatures up to 420 degrees F.
- 2.02 The cable's self-regulating technology shall be such that surface temperature of the cable does not exceed its built-in maximum or "ceiling" even if overlapped or installed with poor pipe contact.

PART 3 - EXECUTION

- 3.01 The heating cable shall be installed under the pipe's thermal insulation without spiraling and with sufficient heat output to maintain the pipe temperature of no less than 40 degrees F when outside ambient is -20 degrees F and the average wind speed is 15 MPH.
- 3.02 After cable installation and before and after installation of THERMAL pipe insulation, the heating cable shall be tested using a 5,000 volt megger. Minimum ELECTRICAL insulation resistance shall be 20 megohms regardless of circuit length. Both bus wires shall be tested to verify the connection of all splices and tees. All material shall be installed in accordance with the manufacturer's recommendations.
- 3.03 Provide class B ground fault trip on all circuit breakers feeding heat tracing circuits.
- 3.04 Heat tracing circuits to be thermostatically controlled.

END OF SECTION

SECTION 16532

WOODEN POLES

PART 1 - GENERAL

1.01 Provide poles as shown and sized on the plan sheets.

PART 2 - PRODUCTS

2.01 Wooden poles used for all electrical installations, if required, shall be of the size and class required having an ultimate fiber strength of 7,500 psi and treated with a minimum of ASA 12 lb. "Penta." Class limitations are given in the following table.

POLE DIMENSIONS, STRENGTHS AND LOADS								
	Pole Class							
	1	2	3	4	5	6	7	
Min. Top Circum. (in.)	27	25	23	21	19	17	15	
Min. Top Dia. (in.)	8.6	8.0	7.3	6.7	6.0	5.4	4.8	
Length (Feet)	Minimum Circumferences Six Feet from Butt (in.)							Setting Depth
30	37.5	35.0	32.5	30.0	28.0	26.0	24.0	5'-6"
35	40.0	37.5	35.0	32.0	30.0	27.5	25.2	6'-0"
40	42.0	39.5	37.0	34.0	31.5	29.0	27.0	6'-0"
45	44.0	41.5	38.5	36.0	33.0	30.5	28.5	6'-5"
50	46.0	43.0	40.0	37.5	34.5	32.0	29.5	7'-0"
55	47.5	44.5	41.5	39.0	36.0	33.6	--	7'-6"
60	49.5	46.0	43.0	40.0	37.0	34.5	--	8'-0"
65	51.0	47.5	44.5	41.5	38.5	--	--	8'-6"
70	52.5	49.0	46.0	42.5	39.5	--	--	9'-0"

2.02 Poles to be compatible to REA Specifications.

PART 3 - EXECUTION

3.01 Pole top to be protected by a pole cap to prevent rain entry.

3.02 Poles set for electrical equipment shall be installed as shown on the plan sheets.

- 3.03 Holes shall be vertically drilled or hand dug to the depth specified on the plan sheets. The hole shall be twelve (12) inches in diameter larger than the butt end of the pole.
- 3.04 Upon digging of the hole, the pole shall be placed in a vertical position and held in place until backfill is complete. Backfill shall be hand placed and tamped to 95% in six-inch layers using materials expelled from the hole. Upon completion, backfill shall be mounded not less than eight inches around the pole.

END OF SECTION

SECTION 16601

LIGHTNING PROTECTION

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Contractor shall provide all labor, materials and items of service required for the completion of a functional and unobtrusive system of air terminals, conductor, grounds and other components necessary for the protection of the building against damage by lightning.
- B. The system shall be completely concealed where possible, with only the air terminals and roof conductor visible, and complying in all respects with the following Codes:
 - 1. Underwriters' Laboratories, Inc. - No. UL96A.
 - 2. National Fire Protection Association - No. NFPA780.
- C. The installing contractor shall be actively engaged in the installation of lightning protection systems, and shall be so listed by Underwriters' Laboratories. He shall have a minimum of three years experience in this work.
- D. The Contractor shall have the shop drawings signed and sealed by a registered engineer specializing in lightning protection design.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials used shall be new and be the product of a manufacturer member of Lightning Protection Institute, approved and labeled by U.L. and L.P.I.
- B. All conductors, terminals and fittings at the roof line shall be aluminum and all components below the roof line shall be copper.
- C. All conductors, terminals and fittings shall be copper or bronze.

PART 3 - EXECUTION

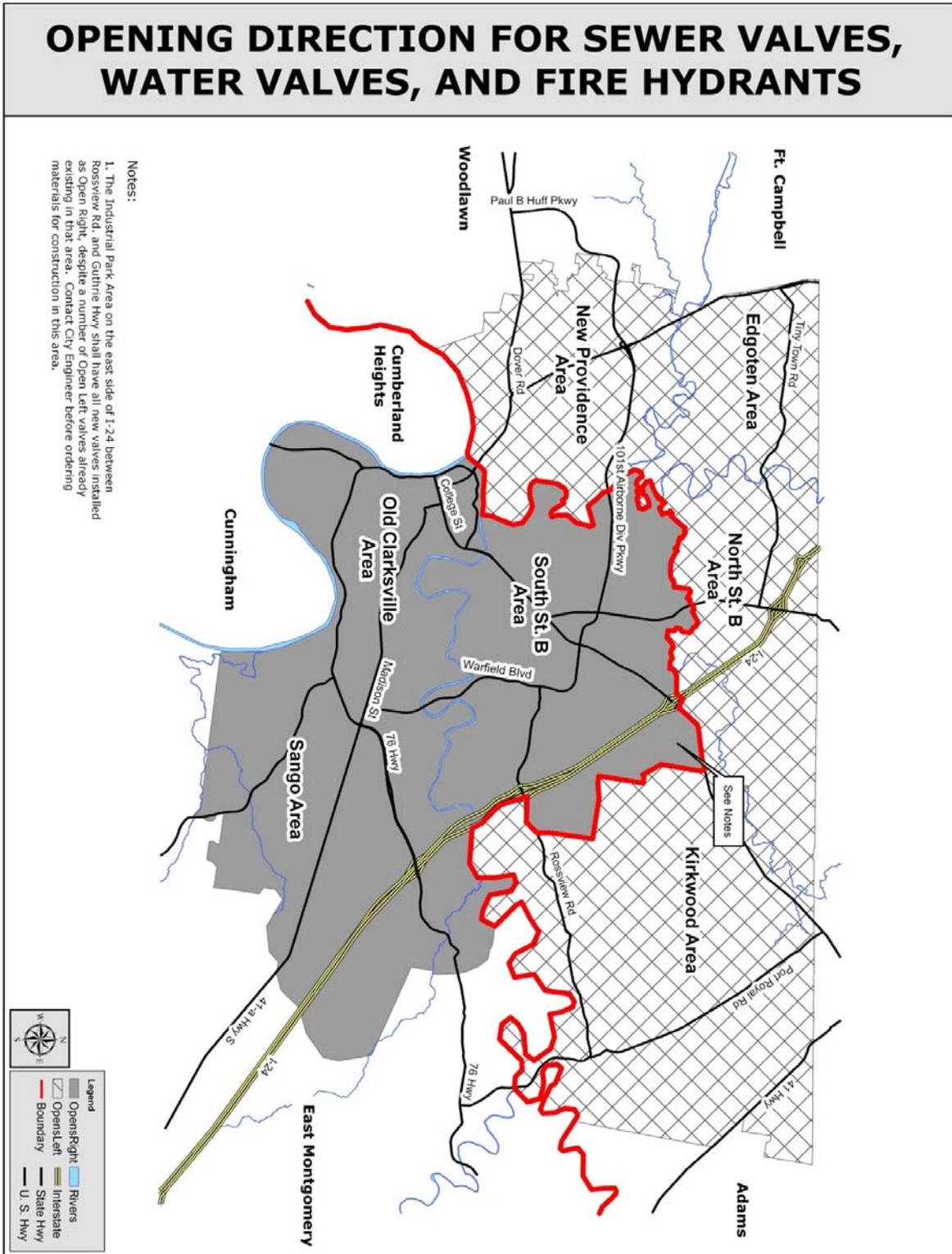
3.01 INSTALLATION

- A. Submit a list of materials and system shop drawings to Engineer for review.

- B. Install all conductors in a downward direction, avoiding trapping or any sharp bends of cables.
- C. New construction: Upon completion of the installation, the Contractor shall complete the application for the U.L. "Master Label" and forward to the manufacturer for processing. The Contractor shall provide a copy of such application to the Engineer. A copy of the application shall be made a part of the project closing files.
- D. Existing construction: If it is determined that the existing buildings do not have UL approved and labeled lightning protection systems, proceed with the new installation, using all labeled materials and meeting all the requirements of the UL 96A Code. Upon completion, the manufacturer shall certify, in writing to the Engineer, that the installation on the new building meets all requirements for the "Master Label" so that the Owner may obtain the UL label at a later date, when an approved installation is made on the older buildings.

END OF SECTION

APPENDIX A - Opening Direction for Sewer Valves, Water Valves and Fire Hydrants



APPENDIX B- Notice of Intent (NOI) Form



Department of Environment and Conservation
Division of Water Pollution Control

CONSTRUCTION ACTIVITY – STORM WATER DISCHARGES NOTICE OF INTENT (NOI)

Site Name:		Existing Tracking No.	
Street Address or Location:		Start date:	
		Estimated end date:	
Site Description:		Latitude:	
		Longitude:	
County(ies):		Acres Disturbed:	
Does a topographic map show dotted or solid blue lines <input type="checkbox"/> and/or wetlands <input type="checkbox"/> on or adjacent to the construction site? If wetlands are located on-site and may be impacted, attach wetlands delineation report. If an Aquatic Resource Alteration Permit has been obtained for this site, what is the permit number? ARAP permit No.:			
Receiving waters:			
Attach the SWPPP with the NOI <input type="checkbox"/> SWPPP Attached		Attach a site location map <input type="checkbox"/> Map Attached	
Site Owner/Developer: (person, company, or legal entity that has operational or design control over construction plans and specifications)			
Site Owner/Developer Contact: (individual responsible for site)		Title or Position:	
Mailing Address:		City:	State: Zip:
Phone: ()		E-mail:	
Optional Contact:		Title or Position:	
Address:		City:	State: Zip:
Phone: ()		E-mail:	
Owner/Developer Certification (must be signed by president, vice-president or equivalent, or ranking elected official)			
I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.			
Owner/Developer name; print or type		Signature	Date
Contractor(s) Certification (must be signed by president, vice-president or equivalent, or ranking elected official)			
I certify under penalty of law that I have reviewed this document, any attachments, and the SWPPP referenced above. Based on my inquiry of the construction site owner/developer identified above, and/or my inquiry of the person directly responsible for assembling this NOI, I believe the information submitted is accurate. I am aware that this NOI, if approved, makes the above-described construction activity subject to NPDES permit number TNR100000, and that certain of my activities on-site are thereby regulated. I am aware that there are significant penalties, including the possibility of fine and imprisonment for knowing violations, and for failure to comply with these permit requirements.			
Primary contractor name and address; print or type		Signature	Date
Other contractor name and address; print or type		Signature	Date
Other contractor name and address; print or type		Signature	Date
OFFICIAL STATE USE ONLY			
Received Date	Reviewer	Field Office	Permit Number TNR
Fee(s)	T & E Aquatic Fauna	Impaired Receiving Stream	High Quality Water Notice of Coverage Date

CN-0940 (Rev. 05-05)

RDAs 2399 and 2400

(continued on reverse)

**CONSTRUCTION ACTIVITY – STORM WATER DISCHARGES
NOTICE OF INTENT (NOI) - INSTRUCTIONS**

Purpose of this form A completed notice of intent (NOI) must be submitted to obtain coverage under the Tennessee General NPDES Permit for Discharges of Storm Water Associated with Construction Activity. **Requesting coverage under this permit means that an applicant has obtained and examined a copy of this permit, and thereby acknowledges applicant’s claim of ability to be in compliance with permit terms and conditions.** This permit is required for storm water discharge(s) from construction activities including clearing, grading, filling and excavating (including borrow pits) of one or more acres of land. This form should be submitted at least 30 days prior to the commencement of land disturbing activities, or no later than 48 hours prior to when a new operator assumes operational control over site specifications or commences work at the site.

Permit fee (see table below) must accompany the NOI and is based on total acreage to be disturbed by an entire project, including any associated construction support activities (e.g. equipment staging yards, material storage areas, excavated material disposal areas, borrow or waste sites). There is no fee for sites less than 1 acre.

Acres Disturbed	Fee	Acres Disturbed	Fee	Acres Disturbed	Fee
= or > 500 acres	\$7,500	= or > 75 < 100 acres	\$2,000	= or > 20 < 30 acres	\$ 500
= or > 250 < 500 acres	\$5,000	= or > 50 < 75 acres	\$1,000	= or > 10 < 20 acres	\$ 400
= or > 150 < 250 acres	\$4,000	= or > 40 < 50 acres	\$ 750	= or > 5 < 10 acres	\$ 300
= or > 100 < 150 acres	\$3,000	= or > 30 < 40 acres	\$ 600	= or > 1 < 5 acres	\$ 250

Who must submit the NOI form? The NOI form must be signed by the “operator(s)” of the construction site. Operators will most likely include the developer of the site, and the primary contractor(s). “Operator” means any party associated with the construction project that meets either of the following two criteria: (1) the party has design or operational control over project specifications (including the ability to make modifications in specifications); or (2) the party has day-to-day operational control of those activities at a project site which are necessary to ensure compliance with the storm water pollution prevention plan (SWPPP) or other permit conditions (e.g., they are authorized to direct workers at the site to carry out activities identified in the storm water pollution prevention plan or comply with other permit conditions). If a contractor has not been identified at the time the NOI is submitted by the developer, the contractor(s) must sign an NOI for the project in order to obtain authorization under this permit. The contractor must include the NPDES permit number that is already assigned to the site, along with the name of the construction project and its location.

Notice of Coverage The division will review the NOI for completeness and accuracy and prepare a notice of coverage (NOC). Storm water discharge from the construction site is authorized as of the effective date of the NOC.

Complete the form Type or print clearly, using ink and not markers or pencil. Answer each item or enter “NA,” for not applicable, if a particular item does not fit the circumstances or characteristics of your construction site or activity. If you need additional space, attach a separate piece of paper to the NOI form. **The NOI will be considered incomplete without a map and the SWPPP.**

Describe and locate the project Use the legal or official name of the construction site. If a construction site lacks street name or route number, give the most accurate geographic information available to describe the location (reference to adjacent highways, roads and structures; e.g. intersection of state highways 70 and 100). Latitude and longitude (expressed in decimal degrees) of the center of the site can be located on USGS quadrangle maps. The quadrangle maps can be obtained at 1-800-USA-MAPS, or at the Census Bureau world wide web site: <http://www.census.gov/cgi-bin/gazetteer>. Attach a copy of a portion of a 7.5 minute quad map, showing location of site, with boundaries at least one mile outside the site boundaries. Provide estimated starting date of clearing activities and completion date of the project, and an estimate of the number of acres of the site on which soil will be disturbed, including borrow areas, fill areas and stockpiles. For linear projects give location at each end of the construction area.

Give name of the receiving waters Trace the route of storm water runoff from the construction site and determine the name of the river(s), stream(s), creek(s), wetland(s), lake(s) or any other water course(s) into which the storm water runoff drains. Note that the receiving water course may or may not be located on the construction site. If the first water body receiving construction site runoff is unnamed (“unnamed tributary”), determine the name of the water body which the unnamed tributary enters.

ARAP permit may be required **If your work will disturb or cause alterations of a stream or wetland, you must obtain an appropriate Aquatic Resource Alteration Permit (ARAP).** If you have a question about the ARAP program or permits, contact your local Environmental Field Office (EFO).

Submitting the form and obtaining more information Note that this form must be signed by the company President, Vice-President, or a ranking elected official in the case of a municipality, for details see permit subpart 2.5. For more information, contact your local EFO at the toll-free number 1-888-891-8332 (TDEC). Submit the completed NOI form (keep a copy for your records) to the appropriate EFO for the county(ies) where the construction activity is located, addressed to **Attention: Storm Water NOI Processing.**

EFO	Street Address	Zip Code	EFO	Street Address	Zip Code
Memphis	2510 Mt. Moriah Road STE E-645	38115-1520	Cookeville	1221 South Willow Ave.	38506
Jackson	1625 Hollywood Drive	38305	Chattanooga	540 McCallie Avenue STE 550	37402-2013
Nashville	711 R S Gass Boulevard	37243	Knoxville	3711 Middlebrook Pike	37921
Columbia	2484 Park Plus Drive	38401	Johnson City	2305 Silverdale Road	37601

APPENDIX C-Construction Storm Water Inspection Certification Form



Department of Environment and Conservation
Division of Water Pollution Control

Construction Storm Water Inspection Certification

(Twice weekly inspections are required for all sites.)

Construction Site Information **Outfall No. ___ (or station no. or other identifier of drainage area represented)**

NPDES Permit No. TNR _____ Notice of Coverage (NOC) Date: _____ County: _____

Name of Project: _____

Developer and/or Contractor Name: _____

Month/Year	Week 1	Week 2	Week 3	Week 4	Week 5
	<i>Yes or No / Initials</i>				
_____, _____	Date: _____	Date: _____	Date: _____	Date: _____	Date: _____
Inspections Performed	/	/	/	/	/
E&S Controls in Order	/	/	/	/	/
_____, _____	Date: _____	Date: _____	Date: _____	Date: _____	Date: _____
Inspections Performed	/	/	/	/	/
E&S Controls in Order	/	/	/	/	/
_____, _____	Date: _____	Date: _____	Date: _____	Date: _____	Date: _____
Inspections Performed	/	/	/	/	/
E&S Controls in Order	/	/	/	/	/
_____, _____	Date: _____	Date: _____	Date: _____	Date: _____	Date: _____
Inspections Performed	/	/	/	/	/
E&S Controls in Order	/	/	/	/	/
_____, _____	Date: _____	Date: _____	Date: _____	Date: _____	Date: _____
Inspections Performed	/	/	/	/	/
E&S Controls in Order	/	/	/	/	/

Provide the following information for the person(s) who have performed and initialed the above inspections. If more than two persons have performed these inspections, give information for the two persons who performed the most numbers of inspections.

Initials: _____	Name: _____	Phone No. _____
Initials: _____	Name: _____	Phone No. _____

Quarterly Inspection Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated information presented. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, I certify that inspections of storm water discharge points (outfalls) and of erosion and sediment controls have been performed as recorded in the table above. I certify that erosion prevention and sediment controls in the drainage area of the identified outfall were installed as planned and designed and in working order as recorded in the table above. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name _____ Title _____ Signature _____

Company _____ Date _____

APPENDIX C-Construction Stormwater Inspection Certification Form

Environmental Field Offices - Division of Water Pollution Control - Addresses

EFO	Street Address	Zip Code	EFO	Street Address	Zip Code
Memphis	2510 Mt. Moriah Road, Suite E-645	38115-1520	Cookeville	1221 South Willow Ave.	38506
Jackson	1625 Hollywood Drive	38305	Chattanooga	540 McCallie Avenue, Suite 550	37402-2013
Nashville	711 R.S. Gass Blvd	37243	Knoxville	3711 Middlebrook Pike	37921
Columbia	2484 Park Plus Drive	38401	Johnson City	2305 Silverdale Road	37601

Information and Instructions

The purpose of this form is to certify that inspections of storm water discharge points and erosion prevention and sediment controls (E&S Controls) at the construction site have been performed. You are required to record your twice-weekly inspections for all sites, but you are only required to record your twice-weekly inspections on this form if discharges from the construction site enter waters that have been identified as being impaired by siltation, or if they enter high quality waters. You can determine whether you are discharging to an impaired or high quality stream by looking at the Notice of Coverage (NOC) returned to you after you applied for coverage under the TNCGP. You may also call your local Environmental Field Office (EFO) at the toll-free number of 1-888-891-TDEC.

You are required to inspect outfall points (where discharges leave the site or enter waters of the state) to ascertain whether your erosion prevention and sediment control measures are effective in preventing soil from leaving the construction site and entering nearby streams. You are also required to inspect the erosion prevention and sediment control measures being used at the site, whether these controls have been installed according to the storm water pollution prevention plan (SWPPP), and whether these controls are in working order. These inspections must be performed at the frequency indicated in the appropriate section of the permit.

To record the inspections and observations, write the date that inspections were performed, in the appropriate week's column; write **Yes** or **No** to indicate if the inspections, both of the outfall points and of the erosion prevention and sediment control measures, were performed; and write **Yes** or **No** to indicate whether or not erosion prevention and sediment controls are installed and in working order. Sign your initials under the date for that week and to the right of the Yes or No. Certification of inspections is required at the end of each quarter and covers all inspections performed during the quarter.

The inspection results shall be kept at the construction site with a copy of the SWPPP. Use a new form for each quarter until the Notice of Termination is filed.

APPENDIX D- Notice of Termination (NOT) Form



Department of Environment and Conservation
Division of Water Pollution Control

NOTICE OF TERMINATION (NOT) – STORM WATER DISCHARGES CONSTRUCTION ACTIVITY

This form is required to be submitted when requesting termination of coverage from the General NPDES Permit for Discharges of Storm Water Associated with Construction Activities. The purpose of this form is to notify the Tennessee Department of Environment and Conservation that you, as a permitted operator of storm water discharges from a construction activity, no longer have responsibilities related to erosion and sediment controls at the construction site. Submission of this form shall in no way relieve the permittee of permit obligations required prior to submission of this form. Please submit this form to the local Division of Water Pollution Control, Environmental Field Office (EFO) address (see table below), and marked “**Storm Water Notice of Termination**”. For more information, contact your local EFO at the toll-free number 1-888-891-8332 (TDEC). **Type or print clearly, using ink and not markers or pencil.**

Site Name:	Tracking No.
Street Address or Location:	
Site Description:	

Site Owner/Developer: (person, company, or legal entity that has operational or design control over construction plans and specifications)			
Site Owner/Developer Contact: (individual responsible for site)		Title or Position:	
Mailing Address:	City:	State:	Zip:
Phone: ()	E-mail:		

Check the reason for termination of permit coverage:

<input type="checkbox"/>	Storm water discharge associated with construction activity is no longer occurring and the area previously under construction has been restabilized (i.e., termination of initial permittee coverage). Explain:
<input type="checkbox"/>	You are no longer the operator of the facility/site (i.e., termination of primary or secondary permittee coverage). Name of Permittee requesting termination of coverage: Explain:

Certification and Signature (must be signed by president, vice-president or equivalent, or ranking elected official)

I certify under penalty of law that either: (a) all storm water discharges associated with construction activity from the portion of the identified facility where I was an operator have ceased or have been eliminated or (b) I am no longer an operator at the construction site. I understand that by submitting this notice of termination, I am no longer authorized to discharge storm water associated with construction activity under this general permit, and that discharging pollutants in storm water associated with construction activity to waters of the United States is unlawful under the Clean Water Act where the discharge is not authorized by a NPDES permit. I also understand that the submittal of this notice of termination does not release an operator from liability for any violations of this permit or the Clean Water Act.

For the purposes of this certification, elimination of storm water discharges associated with construction activity means that all disturbed soils at the portion of the construction site where the operator had control have been finally stabilized and temporary erosion and sediment control measures have been removed or will be removed at an appropriate time to insure final stabilization is maintained, or that all storm water discharges associated with construction activities from the identified site that are authorized by a NPDES general permit have otherwise been eliminated from the portion of the construction site where the operator had control.

Operator name; print or type	Signature	Date
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EFO	Street Address	Zip Code	EFO	Street Address	Zip Code
Memphis	2510 Mt. Moriah Road STE E-645	38115-1520	Cookeville	1221 South Willow Ave.	38506
Jackson	1625 Hollywood Drive	38305	Chattanooga	540 McCallie Avenue STE 550	37402-2013
Nashville	711 R S Gass Boulevard	37243	Knoxville	3711 Middlebrook Pike	37921
Columbia	2484 Park Plus Drive	38401	Johnson City	2305 Silverdale Road	37601

APPENDIX E- CGW Water Customer Data Sheet

CLARKSVILLE GAS & WATER WATER CUSTOMER DATA SHEET

<u>Customer</u>	<u>Address</u>	
<u>Building Address</u>	<u>Zip Code</u>	
<u>Subdivision</u>	<u>Lot No.</u>	<u>Build No.</u>
<u>Type of Occupancy</u>		

<u>Fixture</u>	<u>Fixture Value 60 psi</u>	<u>No. of Fixtures</u>	<u>Fixture Value</u>
Bathtub	8	X	= 0
Bedpan Washers	10	X	= 0
Bidet	2	X	= 0
Dental Unit	2	X	= 0
Drinking Fountain - Public	2	X	= 0
Kitchen Sink	2.2	X	= 0
Lavatory	1.5	X	= 0
Showerhead (Shower Only)	2.5	X	= 0
Service Sink	4	X	= 0
Toilet - Flush Valve	35	X	= 0
- Tank Type	4	X	= 0
Urinal - Pedestal Flush Valve	35	X	= 0
- Wall Flush Valve	16	X	= 0
Wash Sink (Each Set of Facets)	4	X	= 0
Dishwasher	2	X	= 0
Washing Machine	6	X	= 0
Hose (50 ft Wash Down) - 1/2 in.	5	X	= 0
- 5/8 in.	9	X	= 0
- 3/4 in.	12	X	= 0
Combined Fixture Value Total			<u>0</u>
Customer Peak Demand From Fig. 4-2 or 4-3 X Press. Factor			= _____ gpm
Add Irrigation - _____ Sections* X 1.16 or 0.40†			= _____ gpm
- _____ Hose Bibs X Fixture Value X _____ Press. Factor			= _____ gpm
Added Fixed Load			= _____ gpm
TOTAL FIXED DEMAND			= _____ gpm

* 100 ft² area = 1 section

† Spray System - Use 1.16; Rotary Systems - Use 0.40

<u>Fixture</u>	<u>Fixture Value 60 psi</u>		<u>No. of Fixtures</u>		<u>Fixture Value</u>
Bathtub	8	X		=	<u>0</u>
Bedpan Washers	10	X		=	<u>0</u>
Bidet	2	X		=	<u>0</u>
Dental Unit	2	X		=	<u>0</u>
Drinking Fountain - Public	2	X		=	<u>0</u>
Kitchen Sink	2.2	X		=	<u>0</u>
Lavatory	1.5	X		=	<u>0</u>
Showerhead (Shower Only)	2.5	X		=	<u>0</u>
Service Sink	4	X		=	<u>0</u>
Toilet - Flush Valve	35	X		=	<u>0</u>
- Tank Type	4	X		=	<u>0</u>
Urinal - Pedestal Flush Valve	35	X		=	<u>0</u>
- Wall Flush Valve	16	X		=	<u>0</u>
Wash Sink (Each Set of Facets)	4	X		=	<u>0</u>
Dishwasher	2	X		=	<u>0</u>
Washing Machine	6	X		=	<u>0</u>
Hose (50 ft Wash Down) - 1/2 in.	5	X		=	<u>0</u>
- 5/8 in.	9	X		=	<u>0</u>
- 3/4 in.	12	X		=	<u>0</u>
 Combined Fixture Value Total					<u><u>0</u></u>
 Customer Peak Demand From Fig. 4-2 or 4-3 X Press. Factor				=	<u> gpm</u>
Add Irrigation - _____ Sections* X 1.16 or 0.40†				=	<u> gpm</u>
- _____ Hose Bibs X Fixture Value X _____ Press. Factor				=	<u> gpm</u>
Added Fixed Load				=	<u> gpm</u>
TOTAL FIXED DEMAND				=	<u> gpm</u>

* 100 ft² area = 1 section

† Spray System - Use 1.16; Rotary Systems - Use 0.40

APPENDIX F- CGW Lift Station Final Inspection Check List

Clarksville Gas & Water
Lift Station
Final Inspection Checklist

Date: _____	Location: _____
Lift Station ID: _____	kW Meter Number: _____
Pump Manufacturer: _____	Pump Supplier: _____
Pump Model: _____	Serial Number: _____
Voltage: _____	Phase: _____
Hertz: _____	Horsepower: _____
Control Panel Model: _____	Control Panel Supplier: _____
Contractor: _____	Engineer: _____

I. ELECTRIC

- A. Is the power system 3 phase or 1 phase? _____
- B. If 3 phase, is grounded neutral power provided? _____ Yes _____ No
- C. If above answer is "No", is transformer installed? _____ Yes _____ No
- D. Voltage readings
 - Between phases: L1, L2 _____ L1, L3 _____ L2, L3 _____
 - High phase to ground _____
 - Other legs to ground _____
- E. Is High Leg (L3) connected to motor only, and not connected to any auxiliary circuits? _____ Yes _____ No
- F. Do latches on control panel work smoothly? _____ Yes _____ No

II. PUMP AND MOTOR CONTROLS

- A. Do breaker switches operate properly?
 - Pump #1 _____ Yes _____ No
 - Pump #2 _____ Yes _____ No
 - Pump #3 _____ Yes _____ No
 - Pump #4 _____ Yes _____ No
 - Control Circuit _____ Yes _____ No
 - Remote Control Monitor _____ Yes _____ No

B. Hand-Off-Automatic switches:

- Pump #1 hand position operates _____ Yes _____ No
- Pump #2 hand position operates _____ Yes _____ No
- Pump #3 hand position operates _____ Yes _____ No
- Pump #4 hand position operates _____ Yes _____ No
- Do floats sequence all pumps with relation to lead, lag and alternation? _____ Yes _____ No

C. Amperage:

- Name Plate Rating (amps) Pump #1 Motor _____ Yes _____ No
- Amps pulled by Pump #1 Motor _____ Yes _____ No
- Name Plate Rating (amps) Pump #2 Motor _____ Yes _____ No
- Amps pulled by Pump #2 Motor _____ Yes _____ No
- Name Plate Rating (amps) Pump #3 Motor _____ Yes _____ No
- Amps pulled by Pump #3 Motor _____ Yes _____ No
- Name Plate Rating (amps) Pump #4 Motor _____ Yes _____ No
- Amps pulled by Pump #4 Motor _____ Yes _____ No

D. Seal Failure/Heat Sensor:

- Seal failure wires connected properly to seal failure circuit? _____ Yes _____ No
- Test seal failure circuit OK? _____ Yes _____ No
- Heat sensor wires connected properly to heat sensor circuit? _____ Yes _____ No
- Test heat sensor circuit OK? _____ Yes _____ No

E. Control Components:

- Verify all electrical components are locally available _____ Yes _____ No

F. Alarms:

- High water alarm light and horn activated with test button _____ Yes _____ No
- Horn silences with silence button. _____ Yes _____ No
- High water alarm light and horn activate with float. _____ Yes _____ No

G. Float Settings:

- Lead pump kicks on at Elevation _____ ' _____ " from wet well bottom
- Lag pump kicks on at Elevation _____ ' _____ " from wet well bottom
- Back up pump kicks on at Elevation _____ ' _____ " from wet well bottom
- Back up pump kicks on at Elevation _____ ' _____ " from wet well bottom
- Height of influent sewer above floor of wet well _____ ' _____ "
- Height of high water alarm above floor of wet well _____ ' _____ "
- Top of basin Elevation _____ ' _____ "
- Total basin depth _____ ' _____ "

Remarks:

III. **PUMPS AND MOTORS**

A. Operations:

1. Are Pumps running quietly?

- Pump #1 _____ Yes _____ No
- Pump #2 _____ Yes _____ No
- Pump #3 _____ Yes _____ No
- Pump #4 _____ Yes _____ No

2. Are Motors running quietly?

- Pump #1 _____ Yes _____ No
- Pump #2 _____ Yes _____ No
- Pump #3 _____ Yes _____ No
- Pump #4 _____ Yes _____ No

3. Is excessive Vibration noted?

- Pump #1 _____ Yes _____ No
- Pump #2 _____ Yes _____ No
- Pump #3 _____ Yes _____ No
- Pump #4 _____ Yes _____ No

B. Installation:

- Are guide rails exactly vertical (plumb)?
- Is base elbow installed level?

Remarks: _____

IV. **REMOTE MONITOR PANEL**

A. Verify start-up procedure completed properly and put "On-Line" with the Control SCADA room remote monitor panel supplier. _____ Yes _____ No

V. **VALVES**

A. Check valves:

- Do clappers swing freely? _____ Yes _____ No
- Does packing leak? _____ Yes _____ No
- Are counter weights adjusted properly? _____ Yes _____ No

B. Plug valves:

- Do valves open and close freely? _____ Yes _____ No
- Does packing leak? _____ Yes _____ No
- During operation, are all gates completely open? _____ Yes _____ No

Remarks: _____

VI. **PUMP STATION TESTING**

A. Draw Down Test

Diameter of wet well _____' _____"
 (5'-0"=147 gal/ft 6'-0"=212 gal/ft 7'-0"=288 gal/ft 8'-0"=376 gal/ft 10'-0"=587 gal/ft)

	Time	Depth	Vol. Per Unit Depth	Total Vol.	Pump Capacity
Pump #1 On	_____	_____			
Pump #1 Off	_____	_____	_____	_____	_____
Pump #2 On	_____	_____			
Pump #2 Off	_____	_____	_____	_____	_____
Pump #3 On	_____	_____			
Pump #3 Off	_____	_____	_____	_____	_____
Pump #4 On	_____	_____			
Pump #4 Off	_____	_____	_____	_____	_____
Pump #1,2 On	_____	_____			
Pump #1,2 Off	_____	_____	_____	_____	_____
Pump #1,3 On	_____	_____			
Pump #1,3 Off	_____	_____	_____	_____	_____
Pump #1,4 On	_____	_____			
Pump #1,4 Off	_____	_____	_____	_____	_____
Pump #2,3 On	_____	_____			
Pump #2,3 Off	_____	_____	_____	_____	_____
Pump #2,4 On	_____	_____			
Pump #2,4 Off	_____	_____	_____	_____	_____
Pump #3,4 On	_____	_____			
Pump #3,4 Off	_____	_____	_____	_____	_____
Pump #1,2,3 On	_____	_____			
Pump #1,2,3 Off	_____	_____	_____	_____	_____

Time	Depth	Vol. Per Unit Depth	Total Vol.	Pump Capacity
Pump #1,2,4 On _____	_____	_____	_____	_____
Pump #1,2,4 Off _____	_____	_____	_____	_____
Pump #1,3,4 On _____	_____	_____	_____	_____
Pump #1,3,4 Off _____	_____	_____	_____	_____
Pump #2,3,4 On _____	_____	_____	_____	_____
Pump #2,3,4 Off _____	_____	_____	_____	_____
Pump #1,2,3,4 On _____	_____	_____	_____	_____
Pump #1,2,3,4 Off _____	_____	_____	_____	_____

B. Pressure Test

- No Pumps Running – Static Back Pressure: _____
- Pump No. 1 Operating – Pressure: _____
- Pump No. 2 Operating – Pressure: _____
- Pump No. 3 Operating – Pressure: _____
- Pump No. 4 Operating – Pressure: _____
- Pump Nos. 1 & 2 Running – Pressure: _____
- Pump Nos. 1 & 3 Running – Pressure: _____
- Pump Nos. 1 & 4 Running – Pressure: _____
- Pump Nos. 2 & 3 Running – Pressure: _____
- Pump Nos. 2 & 4 Running – Pressure: _____
- Pump Nos. 3 & 4 Running – Pressure: _____
- Pump Nos. 1,2 & 3 Running – Pressure: _____
- Pump Nos. 1,2 & 4 Running – Pressure: _____
- Pump Nos. 1,3 & 4 Running – Pressure: _____
- Pump Nos. 2,3 & 4 Running – Pressure: _____
- Pump Nos. 1,2,3 & 4 Running – Pressure: _____

Remarks: _____

VII. **EQUIPMENT (Verify operation and list what is in need of correction)**

- Pumps
- Motors
- Pump Circuit Breaker
- Starters
- Heaters
- Control Circuit Breaker
- Remote Monitor Circuit Breaker
- Alternator
- H-O-A Switches
- Plug Valves
- Check Valves
- Pressure Gauge
- Transducer
- Floats
- Other

Remarks: _____

VIII. **SCADA ALARM SYSTEM**

A. Do latches on control panel work smoothly? _____ Yes _____ No

B. Code indication functioning

- Pump overload trip _____ Yes _____ No
- Crew on site key switch _____ Yes _____ No
- Wet well high water _____ Yes _____ No
- Dry pit high water or submersible seal failure _____ Yes _____ No
- Power failure _____ Yes _____ No
- Open _____ Yes _____ No
- Restore to normal _____ Yes _____ No
- Low battery _____ Yes _____ No

Remarks: _____

I CERTIFY THIS REPORT IS ACCURATE

Start-up date/time

Start-up Coordinator

Factory Representative

Wastewater Utility Superintendent

Wastewater Utility Operator

Engineer

Contractor