STANDARD SPECIFICATIONS

FOR

SEWER LINES

LEWISBURG, TENNESSEE

MARCH 2022



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SECTION 01010 GENERAL REQUIREMENTS

- 1. The words "A/E," "Owner," "City of Lewisburg," and "Lewisburg Water and Wastewater" are to be used interchangeably.
- 2. Construction of sewer lines may not begin prior to approval by the Lewisburg Water and Sewer Department
- 3. The City of Lewisburg will not accept sewer lines that were not approved in accordance with these specifications.
- 4. The City of Lewisburg requires the following bonds (or certified cashier's check):
 - a. Performance Bond 100% of estimated construction cost, to be returned to Contractor/Developer upon acceptance of the improvements by the City.
 - b. Road Repair Bond 100% of estimated roadway (public) repair cost, amount to be set by street department to be returned to Contractor/Developer upon acceptance of the repaired/replaced roadway by the Street Department.
 - c. Guarantee Bond Amount specified by the City, to be returned to Contractor/Developer at end of guarantee period. It is anticipated that this bond will only be required under special circumstances. Contractor/Developer to be notified at time of approval by Water and Sewer Department if this bond is required.
- 5. Service connection and service line construction to property line or right-of-way (only) is covered herein. Service line construction from property line or right-of-way to structure is covered in the latest edition of the Standard Plumbing Code. Smaller lines shall not be connected to larger lines by utilizing a concrete collar. Only an approved compression or rubber O-ring style coupling will be acceptable. The practice of "hammer tapping" a sewer line is not in conformance with the Standard Plumbing Code and is not an acceptable method of connecting a service line to a new or existing sewer line. In all cases, a tee, wye, or tapping saddle shall be used. Contractors and/or plumbers caught or suspected of utilizing either illegal practice hereinbefore discussed will be asked to provide a guarantee bond as specified in 4.c hereinbefore prior to being allowed to complete improvements to Lewisburg Sewer System.
- 6. Water service may be denied to structures connected to a sewer line or service not accepted by the City.
- 7. All sewer lines and services (to property line right-of-way only) constructed utilizing these or similar specifications become the property of the City of Lewisburg upon acceptance by the City. Sewer lines and services (to property line or right-of-way only)

will not be accepted by the City unless and until they are in strict conformance with these specifications.

- 8. Four (4) sets of drawings including vicinity map shall be submitted to the Water and Sewer Department for approval. After approval, the Developer shall submit 3 sets of signed drawings to the Tennessee Department of Environment and Conservation for their approval. One state approved set of drawings and one copy of the state approval letter shall be returned to the Manager of Water and Sewer Department prior to beginning construction. Prior to acceptance of lines by the City, one set of "Record" drawings showing all changes, service locations, and other data not shown on the original set shall be given to the Manager of Water and Sewer Department.
- 9. Detail drawings and specifications shall be submitted by the A/E employed by the Developer for any special condition or structures such as pump stations, creek crossings, etc., and approved by the City before beginning any construction.
- 10. Easements required across private property or in roads to be acquired by the Developer in the name of the City. Easements shall have a minimum width of 20'. Wider easements may be required for sewers over 10' deep. Easements shall be recorded as "Permanent Utility Easements".
- 11. All applicable Federal and State laws, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the construction throughout.
- 12. No utility plans for subdivision developments will be reviewed until the development has received preliminary plat approval by the Planning Commission.
- 13. Sewer Plan and profile sheets shall be furnished for review. All plans and hydraulic profiles shall be prepared by an engineer licensed to practice in Tennessee and shall bear his/her seal and signature and date.
- 14. If construction has not started within one year from date of approval, plans will have to be resubmitted to renew approval.
- 15. Elevations shall be on sea level datum, assumed elevations are not acceptable.
- 16. Any special requirements shall be transmitted as a part of the approval granted by the Water and Sewer Department.

End of Section 01010

General Conditions Section 01011

- 1. The purpose of these specifications is to provide a guide to the Developers and their Contractors in order to achieve an acceptable installation for furnishing of sewer service to subdivisions or other areas in the City of Lewisburg.
- 2. No valve or cutoff shall be operated except by a City of Lewisburg Representative.
- 3. No utility plans will be reviewed until the development plans have received preliminary approval by the Planning Commission having jurisdiction.
- 4. A set of reproducible plans corrected as "Record Drawings" shall be given to the City of Lewisburg after each project is completed. The "Record Drawings" shall be an approved set of subdivision plans and shall show locations of all manholes, sewer mains, service lines, clean outs, and other appurtenances.
- 5. Sizes and locations of manholes, sewer mains, and service lines shall be in accordance with the plans approved by City of Lewisburg.
- 6. Detailed plans and specifications shall be submitted by the Engineer employed by the Developer for any special condition or structures such as pump stations, force mains, creek crossings, etc., and shall be approved by the City of Lewisburg before beginning any construction. The plans and specifications shall bear the stamp of an Engineer licensed to practice engineering in the State of Tennessee.
- 7. "Cut-ins" or taps to live mains shall be made only in the presence of a City of Lewisburg Representative.
- 9. Permits for pavement cuts or crossing of public roads, including any special backfill and pavement repair as required by the agency having jurisdiction, are the responsibility of the Developer. A bond shall be provided to the City of Lewisburg by the Developer to cover all costs of repair and maintenance for a period of one year from the date of acceptance of the project for all work performed in existing rights-of-way of all roads in Marshall County and all State highways. The amount of this bond shall be determined by the City of Lewisburg after it receives all requirements for repairs from the County Highway Department or the Tennessee Department of Transportation.
- 10. Easements must be acquired by the Developer in the name of the City with a minimum width of 20 feet. The city reserves the right to require wider easements for deeper sewer lines.
- 11. All applicable Federal and State laws, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the contract throughout.
- 12. If construction has not started within one year from the date of approval, utility plans shall be resubmitted to resubmitted to renew approval.

General Conditions Section 01011

- 13. Laboratory and mill test started within one year from the date of approval, utility plans shall be resubmitted to renew approval.
- 14. Centerlines of proposed roads shall be staked before beginning construction. The road section and sewer line relation to the centerline of the road shall be shown on the plans. Front-lot corners shall be marked before services are installed in order for services to be properly located.
- 15. In subdivisions, all grading work shall be submitted to the City of Lewisburg for the proposed system.
- 16. Hydraulic calculations and data shall be submitted to the City of Lewisburg for the proposed system.
- 17. Before beginning any construction, the Developer shall contact the City of Lewisburg and schedule a preconstruction conference to be held between the Contractor, Developer, and/or his Engineer, and the City of Lewisburg. At this meeting, the Contractor will be informed of the City's policies and any special requirements.
- 18. Any construction shall be performed by a contractor licensed by the State of Tennessee. The Contractor's license limit shall be adequate for the project. The license classification shall include MU, Municipal and Utility Construction.
- 19. Submit a list of material suppliers, and technical submittals for the city's approval. Such submittals shall be at least 30 days before start of construction.
- 20. Each lot or sewer customer shall be supplied with an individual sewer service line, and service tap. A department inspection must confirm that a watertight connection is properly completed prior to the covering of the tap connecting to the owner's sewer line. Failure to do so will result in the owner re-opening the tap for inspection.
- 21. All sewer mains and services crossing roads or future roads shall be cased in accordance with specification Section 02725 whether the installation is by open cut or by boring.

End of Section 01011

Special Project Procedures Section 01031

1. Smoking and Fire Precautions

1.1 No smoking, fire, or use of any fire – or explosion-producing tools or equipment will be permitted on the properties of oil companies or other concerns prohibiting same on their premises or at any location where such may endanger said premises or the current operations thereon.

2. Manufacturers' Qualifications

2.1 The manufacturers of all materials and equipment used must be reputable and regularly engaged in the manufacture of the particular material or equipment for the use and service to which it will be subjected.

3. Contract Shall Pay for All Laboratory Inspection Service

3.1 All materials and equipment used in the construction of the project shall be subject to adequate inspection and testing in accordance with accepted standards. The laboratory or inspection agency shall be selected by the Contractor and approved by the Owner. Pay for all laboratory inspection services as a part of the Contract. Submit all material test reports to the A/E in triplicate.

4. Compliance with State and Local Laws

4.1 Comply with all applicable requirements of state and local laws and ordinances to the extent that such requirements do not conflict with federal laws or regulations.

5. **Protection of Public and Private Property**

5.1 Take special care in working areas to protect public and private property. The Contractor shall replace or repair at his own expense any damaged water pipes, power and communication lines, or other public utilities, roads, curbs, gutters, sidewalks, drainage pipes, sewer, drainage ditches, and all plantings, including grass or sod on the site of the work. Leave the site in original or better condition after all cleanup work has been done.

6. Markers

6.1 Preserve all USGS, TVA, State of Tennessee, and private markers; do not remove or disturb any such markers without prior approval from the A/E and the applicable Agency. Any removal and replacement of such markers shall be at the expense of the Contractor.

7. Pavement Repair and/or Replacement

7.1 Whenever pipe trenches are cut across or along existing pavement or shoulders, backfill same and restore traffic over the cuts as quickly as possible by constructing a temporary twelve-inch (12") surface of Class A, Grade D crushed stone. Add material and otherwise maintain such surface until the permanent pavement is restored or until the entire project is accepted.

8. Department of Transportation Permits

8.1 The Developer will secure any permits and provide bond as required by the Tennessee Department of Transportation for installation of permanent facilities on highway rights-of-way. All such work shall be coordinated with and be subject to the approval of the Department of Transportation, in addition to the approval of the A/E.

9. Boring

9.1 Where sewer mains are to cross railroads, paved state or federal roads, or certain city roads, they are to be bored, see Section 02725, Boring and Casing for Sanitary Sewer. Service lines may be bored or open cut, at the discretion of the city.

10. Approved Chemicals

10.1 All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, must show approval of either EPA or USDA. The use of all such chemicals and the disposal of residues shall be in strict conformance with instructions.

11. Installation, Testing, and Guarantee

11.1 Install all motor driven equipment exactly in accordance with the manufacturer's recommendations. Do not operate the units except to check the direction of rotation, etc., unless a representative of the manufacturer--who shall perform all required field testing--is present. The completely installed system shall be guaranteed against any and all defects of manufacture, materials, workmanship, or installation for a period of one year from the date of acceptance.

12. Drawings of Record

12.1 Provide and keep up-to-date a complete record set of blueline prints, which shall be corrected daily to show every change, and the approved shop drawings. Keep this set of prints at the job site and use only as a record set. This shall not be

construed as authorization for the Contractor to make changes in the approved layout without definite instructions in each case. Turn the set over to the Water and Sewer Department upon completion of the project.

13. Wastewater Bypassing

13.1 No wastewater bypassing during construction will be allowed unless a schedule has been approved by the Water and Sewer Department and the Tennessee Division of Water Resources as required pursuant to the terms of the NPDES permit.

14. Utilities

14.1 The Contractor is to contact the Owner of all underground utilities before beginning construction in the area. Carefully protect all utilities from damage in the vicinity of the work at all times. If it is necessary to repair, remove, and/or replace any such utility in order to complete the work properly, do so in compliance with the rules and regulations of the particular utility involved. Tennessee "One-Call" shall be utilized to meet this requirement as a minimum standard. It may still be necessary to contact individual utilities for specific information.

End of Section 01031

SECTION 01090 STANDARDS

1. <u>GENERAL</u>

Meet the requirements and recommendations of all standards, institutes, associations, etc., referred to throughout these documents and specifications as if they were fully reproduced herein. Unless otherwise noted, the latest edition shall apply.

2. <u>ABBREVIATIONS</u>

AAMA - Architectural Aluminum Manufacturer's Association AASHTO - American Association of State Highway and Transportation Officials ABMA - American Boiler Manufacturer's Association **ACI - American Concrete Institute** AFBMA - Anti-Friction Bearing Manufacturer's Association AGA - American Gas Association AGC - Association of General Contractors AGMA - American Gear Manufacturer's Association AIA - American Institute of Architects AIEE - American Institute if Electrical Engineers AIMA Acoustical and Insulating Materials Association AISC - American Institute of Steel Construction AISI - American Iron and Steel Institute AITC - American Institute of Timer Construction AMCA - Air Moving and Conditioning Association ANSI - American National Standards Institute **APA - American Plywood Association API - American Petroleum Institute** ARI - Air Conditioning and Refrigeration Institute ASA - American Standards Association ASAE - American Society of Automotive Engineers ASC - Association of Specialty Contractors ASCII - American Standard Code for Information Interchange ASHRAE - American Society of Heating, Refrigeration, and Air Conditioning Engineers ASME - American Society of Mechanical Engineers ASTM - American Society for Testing and Materials AWI - Architectural Woodwork Institute AWPB - American Wood Preservers Bureau **AWPI - American Wood Preservers Institute** AWS - American Welding Society AWWA - American Water Works Association **BIA - Brick Institute of America** CMAA - Crane Manufacturer's Association of America

CRSI - Concrete Reinforcing Steel Institute

CS - Commercial Standards

CSI - Construction Specifications Institute

EPA - Environmental Protection Agency

FAA - Federal Aviation Administration

FGMA - Flat Glass Marketing Association

FM - Associated Factory Mutual Laboratories

FS - Federal Specifications

IEEE - Institute of Electrical and Electronic Engineers

IRI - Industrial Risk Insurers

ISA - Instrument Society of America

JIC - Joint Industrial Council

MBMA - Metal Building Manufacturers Association

MMA - Monorail Manufacturers' Association

NAAMM - National Association of Architectural Metal Manufacturers

NBS - National Bureau of Standards

NEC - national Electrical Code

NEMA - national Electrical Manufacturer's Association

NFPA - National Fire Protection Association or National Forest Products Association

NKCA - National Kitchen Cabinet Association

NPT - National Pipe Thread

NRCA - National Roofing Contractors Association

NSF - National Sanitation Foundation

NSWMA - National Solid Waste Manufacturers Association

NWMA - National Woodwork Manufacturing Association

OSHA - Occupational Safety and Health Administration

PPI - Plastics Pipe Institute

RIS - Redwood Inspection Service

SAE - Society of Automotive Engineers

SBCC - Standard Building Code Congress

SDI - Steel Deck Institute

SJI - Steel Joist Institute

SMACNA - Sheet Metal and Air Conditioning Contractor's National Association

SPII - Southern Pine Inspection Institute

SSBC - Southern Standard Building Code

SSPC - Steel Structures Painting Council

TCA - Tile Council of America

TDOT - Tennessee Department of Transportation

TIMA - Thermal Insulation Manufacturers' Association

UL - Underwriters' Laboratories

USG - United States Gypsum

WCLIP - West Coast Lumber Inspection Bureau

WWPA - Western Wood Products Association

END OF SECTION 01090

SECTION 01568 EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

- A. This work shall consist of erosion control on all excavations and disturbed areas, and fill operations, excavation, backfill, or other construction activities within the limits of the easements, and within any borrow site used during the period of construction. The protection of these sites shall continue throughout the construction period. During flood seasons, protect the sites by sandbagging, the pumping of water, and any other means appropriate to restrain flooding of plant and equipment. 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.
- B. 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.
- C. It is the intent of this section to provide a written plan to ensure that Division of Water Resources General Stormwater Permit for Construction Activities and/or General ARAP Permit for Utility Line Crossings of streams are met. Since the Contractor is responsible for the construction means and methods which in turn are responsible for ensuring that construction does not harm the Waters of Tennessee, the Contractor is solely responsible for ensuring that the above-mentioned permitting requirements are met.

PART 2 PRODUCTS

2.1 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.

2.2 TEMPORARY SLOPE DRAINS

A. 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 stormwater down slopes to reduce erosion.

2.3 SEDIMENT STRUCTURES

A. Sediment basins, ponds, 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.

2.4 CHECK DAMS

A. Check dams are barriers composed of large stones, sand bags, or other nonerodable materials placed across or partially crossing a natural or constructed drainway. Check dams are not to be placed in waters of the state unless an ARAP Permit has been approved to do so.

2.5 TEMPORARY SEEDING AND MULCHING

A. 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.

2.6 TEMPORARY SILT FENCES or TUBE BARRIERS

- A. 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.
- B. Sediment tubes such as the Erosion Eel may be substituted for silt fence in most applications. If the plans do not specifically call for silt fence or a tube then permission must be granted by the engineer to make a substitution. Sediment tubes are often more suitable for linear utility projects or projects where rock is very shallow.

PART 3 EXECUTION

3.1 PROJECT REVIEW

A. At the preconstruction conference, the Contractor and the A/E shall go over in detail the expected problem areas in regard to the erosion control work. Different solutions should be discussed so that the best method might be determined.

3.2 STORMWATER PERMITTING AND STORMWATER POLLUTION PREVENTION PLAN

A. CONSTRUCTION STORMWATER PERMITTING

All construction projects that disturb at least one acre of ground are required to obtain coverage under a General Stormwater Permit from the Tennessee Division of Water Resources. For City Projects, the Owner will submit the necessary application for coverage prior to the start of construction on the project. For private projects, the Developer shall submit the necessary application for coverage. All main line construction projects, regardless of size, shall obtain a Land Disturbance Permit from the City of Lewisburg Stormwater Department.

B. STORMWATER POLLUTION PREVENTION PLAN

Projects receiving coverage under the Tennessee General Stormwater Permit for Construction Activity are required to have a Stormwater Pollution Prevention Plan (SWPPP) on site while construction is taking place. For City Projects, the Owner will develop the necessary Plan and will provide a copy to the Contractor prior to the start of construction. It shall be the responsibility of the Contractor to maintain compliance with the requirements of the Plan. In general the SWPPP will require that stockpiles be protected by sedimentation structures such as silt fence or by temporary seeding for long term protection. Work being performed adjacent to Waters of the State will be protected from erosion at all times. Any other project areas thought to pose a potential sedimentation risk to Waters of the State will be protected as described in the SWPPP. For private projects, the Developer shall include all construction required for utility installation in the SWPPP for the development.

C. CERTIFIED INSPECTIONS

Projects receiving coverage under the Tennessee General Stormwater Permit for Construction Activity are required to be inspected twice per week by a "Certified Inspector". To qualify, the inspector must have completed the Level 1 course in the Fundamentals of Erosion Prevention and Sedimentation Control as offered by the University of Tennessee. The inspector's certification must be current, meaning that the Level 1 Course or the Recertification Course have been completed within the previous 3 years. For all projects, the Contractor shall be responsible for providing the twice per week inspection services for the life of the project.

3.3 SPILL PREVENTION PLAN

A. All projects where 1,320 gallons or more of oil and/or fuel products are to be stored will require a Spill Prevention Control and Countermeasures (SPCC) Plan, as required by the Clean Water APRIL 2021 01568 - 3 Act. In such case, the Contractor shall be responsible for development of the SPCC Plan and shall submit a copy to the owner prior to the storage of the products on the construction site. The Owner reserves the right to require the Contractor to submit a spill prevention plan for smaller quantities or different types of chemicals if it is deemed necessary for the health and safety of the public and/or the protection of the environment.

3.4 CONSTRUCTION REQUIREMENTS

- A. The A/E 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 temporary contamination of adjacent streams or other watercourses, lakes, ponds, or construction of temporary berms, dikes, dams, sediment basins, slope or other control devices or methods as necessary to control erosion. Cut and fill slopes shall be seeded and mulched as the excavation proceeds to the extent directed by the A/E.
- B. The Contractor shall be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in the SWPPP. Temporary pollution control measure shall be used to correct conditions that develop during construction that were not foreseen during the preconstruction stage; that are needed prior to installation of permanent pollution control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.
- 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 stages.
- D. The A/E 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 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.

END OF SECTION

SECTION 01600 MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Products.
- B. Transportation and handling.
- C. Storage and protection.
- D. Product options.
- E. Substitutions.

1.02 RELATED SECTIONS

- A. Document 01010 General Requirements
- B. Section 01011 General Conditions.

1.03 PRODUCTS

A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for reparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse

B. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents or the Water and Sewer Department.

C. Provide interchangeable components of the same manufacturer, for similar components.

1.04 TRANSPORTATION AND HANDLING

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.

Section 01600 (continued)

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.05 STORAGE AND PROTECTION

A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.

B. For exterior storage of fabricated products, place on sloped supports, above ground.

C. Provide off-site storage and protection when site does not permit on-site storage or protection.

D. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

E. Store loose granular materials on solid flat surfaces in a well-drained area. Provide mixing with foreign matter.

F. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

G. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.

1.06 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

1.07 SUBSTITUTIONS

A. Architect/Engineer will consider requests for Substitutions only within 15 days after date established in Notice to Proceed.

B. Substitutions may be considered when a product becomes unavailable or delayed through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

D. A request constitutes a representation that the Contractor :

1 Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.

2. Will provide the same warranty for the Substitution as for the specified product.

3. Will coordinate installation and make changes to other work which may be required for the Work to be complete with no additional cost to Owner.

4. Waives claims for additional costs or time extension which may subsequently become apparent.

5. Will reimburse Owner for review or redesign services associated with reapproval by authorities.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

F. Substitution Submittal Procedure:

1. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.

2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.

3. The Architect/Engineer or Water and Sewer Department will notify Contractor, in writing, of decision to accept or reject request.

END OF SECTION 01600

SECTION 02200 EARTHWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Protection, modification, or installation of utilities as sitework progresses with particular attention to grade changes and necessary staging or phasing of work.
- B. Cutting, filling, and grading to required lines, dimensions, contours, and elevations for proposed improvements.
- C. Scarifying, compacting, drying, and removal of unsuitable material to ensure proper preparation of areas for fills or proposed improvements.

1.02 RELATED SECTIONS

- A. Section 02221 Unclassified Excavation for Utilities
- B. Geotechnical Report (if available) for boring locations and findings of subsurface materials and conditions
- C. Storm Water Pollution Prevention Plan
- D. Architectural Plans and Specifications as they relate specifically to earthwork beneath buildings, where architectural requirements are more stringent than civil requirements
- E. Construction Drawings

1.03 REFERENCE STANDARDS

- American Society for Testing and Materials (ASTM) latest edition. A. D 698 Laboratory Compaction Characteristics of Soil Using Standard Effort $(12,400 \text{ ft-lbf/ft}^3 (600 \text{ kN}.\text{m/m}^3))$ D 1556Density and Unit Weight of Soil In Place by the Sand-Cone Method D 1557Laboratory Compaction Characteristics of Soil Using Modified Effort $(56.000 \text{ ft-lbf/ft}^3 (2.700 \text{ Kn.m/m}^3))$ D 2167Density and Unit Weight of Soil In Place by the Rubber Balloon Method D 2216Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures D 2487Classification of Soils for Engineering Purposes D 2922Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth) D 3017Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth) D 4318Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition

T 88 Particle Size Analysis of Soils

1.04 QUALITY ASSURANCE

- A. An independent testing laboratory, selected by the Contractor, approved by the Engineer and paid by the Contractor, shall be retained to perform construction testing on site based on following:
 - 1. Building Subgrade Areas, including 10'-0" Outside of Exterior Building Lines: In cut areas, not less than 2 compaction tests equally spaced for every 2,500 sq. ft. In fill areas, same rate of testing for each 8-in. lift, measured loose.
 - 2. Areas of Construction exclusive of Building Subgrade Areas: In cut areas, not less than 2 compaction tests equally spaced for every 10,000 sq. ft. In fill areas, same rate of testing for each 8-in. lift, measured loose.
- B. If compaction requirements are not complied with at any time during construction process, contractor shall remove and recompact deficient areas until proper compaction is obtained at no additional expense to Owner.
- C. In areas to receive pavement, California Bearing Ratio (CBR) or Limerock Bearing Ratio (LBR) test shall be performed for each type of material that is imported from off-site.
- D. Following tests shall be performed as part of construction testing requirements on each type of on-site or imported soil material used as compacted fill:
 - 1. Moisture and Density Relationship: ASTM D 698 (or ASTM D 1557)
 - 2. Mechanical Analysis: AASHTO T 88
 - 3. Plasticity Index: ASTM D 4318
- E. Field density tests for in-place materials shall be performed as part of construction testing requirements according to one of following standards:
 - 1. Sand-Cone Method: ASTM D 1556
 - 2. Balloon Method: ASTM D 2167
 - 3. Nuclear Method: ASTM D 2922 (Method B-Direct Transmission)
- F. An independent testing laboratory shall prepare test reports that indicate test location, elevation data, and test results. Owner, Architect, Engineer, and Contractor shall be provided with copies of reports within 96 hours of time that test was performed. In event that test performed fails to meet Specifications, the Owner or his designated representative and Contractor shall be notified immediately by the independent testing laboratory.
- G. All costs related to retesting due to test failures shall be paid for by Contractor at no additional expense to Owner. Owner reserves right to employ an additional

independent testing laboratory to obtain a second opinion when deemed necessary. Contractor shall provide free access to site for testing activities.

1.05 SUBMITTALS

- A. Submit 100 lb. sample of each type of off-site fill material that is to be used at the site in air tight containers to the independent testing laboratory for testing or submit gradation and certification of aggregate material that is to be used at the site to the independent testing laboratory for review and recommended approval.
- B. Submit name of each material supplier including the specific type and source of each material. Change in material source throughout project requires an additional submittal to the Owner or his designated representative for approval.
- C. If fabrics or geogrids are to be used, specific product design shall be submitted to the Owner or his designated representative for approval.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Excavated and re-used material for subsoil fill as specified herein.
- B. Aggregate fill.
- C. Imported fill material approved by the Owner or his designated representative and specified herein.
- D. Topsoil fill.
- E. Acceptable stabilization fabrics and geogrids.
- F. Filter and drainage fabrics.

2.02 EQUIPMENT

Off-site materials shall be transported to project using well maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping.

PART 3 EXECUTION

3.01 PREPARATION

- A. Identify required lines, spot elevations, contours, and benchmark datum.
- B. Locate and identify existing utilities that are to remain and protect from damage.
- C. Notify utility companies to remove or relocate utilities that are in conflict with proposed improvements.
- D. Protect plant life, lawns, fences, existing structures, sidewalks, paving, and curbs from damage by excavating equipment and vehicular traffic.

- E. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.
- F. Remove from site, material encountered in grading operations that, in opinion of Owner or his designated representative, is unsuitable or undesirable for backfilling, subgrade, or foundation purposes. Dispose of material in manner satisfactory to governing authorities and backfill areas with layers of suitable material and compact as specified.
- G. Prior to placing fill in low areas, such as previously existing creeks, ponds, or lakes, perform following procedures:
 - 1. Drain water out by gravity with ditch having flow line lower than lowest elevation in low area. If drainage cannot be performed by gravity ditch, use adequate pump to obtain same results.
 - 2. After drainage of low area is complete, remove mulch, mud, debris, and other unsuitable material by using acceptable equipment and methods that will keep natural soils underlying low area dry and undisturbed.
 - 3. If muck, mud, and other materials removed from low areas is proposed for fill, it shall be dried on-site by spreading in thin layers for observation. Material shall be inspected and, if found to be suitable for use as fill material, shall be incorporated into lowest elevation of site filling operation, but not under building subgrade areas defined in section 1.04A or within the upper 10 feet of paving subgrade. If, after observation the material is found to be unsuitable, the material shall be removed from site.

3.02 EXCAVATION FOR FILLING AND GRADING

- A. Classification of Excavation: By submitting bid, Contractor acknowledges that site has been investigated to determine type, quantity, quality, and character of excavation work to be performed. Excavation shall be considered unclassified excavation, except as specifically indicated by the Contract Documents.
- B. When performing grading operations during periods of wet weather, provide adequate drainage and ground water management to control moisture of soils.
- C. Shore, brace, and drain excavations as necessary to maintain excavation as safe, secure, and free of water at all times.
- D. Excavated material containing rock or stone greater than 6-in. in largest dimension is unacceptable as fill within proposed building subgrade and paving subgrade.

- E. Rock or stone less than 6-in. in largest dimension is acceptable as fill to within 24-in. of surface of proposed subgrade when mixed with suitable material.
- F. Rock or stone less than 2-in. in largest dimension and mixed with suitable material is acceptable as fill within the upper 24-in. of proposed subgrade.

3.03 FILLING AND SUBGRADE PREPARATION

- A. Fill areas to contours and elevations shown on Construction Drawings with acceptable materials. Use of frozen or frost containing materials is not acceptable for filling operations.
- B. Place fill in continuous lifts as specified herein.
- C. Areas exposed by excavation or stripping and on which subgrade preparations are to be performed shall be scarified to minimum depth of 8-in. and compacted to not less than the minimum dry density listed in Section 3.036, in accordance with ASTM D 698 (or accordance with ASTM D 1557) at a moisture content of not less than 1 percent below and not more than 3 percent above optimum moisture content. These areas shall then be proofrolled to detect areas of insufficient compaction. Proofrolling shall be accomplished by making a minimum of 2 complete passes with fully-loaded tandem-axle dump truck, or approved equal, in each of 2 perpendicular directions while under the supervision and direction of the independent testing laboratory. Areas of failure shall be excavated and recompacted as specified.
- Fill materials used in preparation of subgrade shall be placed in lifts or layers not to exceed 8-in. loose measure and compacted to minimum density listed in Section 3.03 G, in accordance with ASTM D 698, (or in accordance with ASTM D 1557) at a moisture content of not less than 1 percent below and not more than 3 percent above optimum moisture content.
- E. Material imported from off-site shall have CBR or LBR value equal to or above pavement design subgrade CBR or LBR value indicated on Construction Drawings.
- F. Percentage of Maximum Density Requirements
 - 1. Structures: Compact top 12 inches of subgrade and each layer of backfill or fill material at 98 percent maximum dry density (ASTM D698) or 95 percent dry density in accordance with ASTM D1557.
 - 2. Building Slabs and Steps: Compact top 12 inches of subgrade and each layer of backfill or fill material at 98 percent maximum dry density (ASTM D698) or 95 percent maximum dry density (ASTM D1557).

- 3. Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material at 95 percent maximum dry density (ASTM D698) or 92 percent maximum dry density (ASTM D1557).
- 4. Lawn or Unpaved Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material at 90 percent maximum dry density (ASTM D698) or 87 percent maximum dry density (ASTM D1557).
- 5. Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material at 95 percent maximum dry density (ASTM D698) or 92 percent maximum dry density (ASTM D1557).

3.04 MAINTENANCE OF SUBGRADE

- A. Finished subgrades shall be verified to ensure proper horizontal and vertical controls have been complied with and compacted conditions are satisfactory for construction above subgrade.
- B. Contractor shall use any methods necessary to protect the compacted subgrade from erosion, excessive moisture or drying conditions and wheel loading damage during construction from concrete trucks, dump trucks, and other construction equipment.
- C. Remove areas of finished subgrade found to have insufficient compaction density to depth necessary and replace in manner that will comply with compaction requirements by use of material equal to or better than best subgrade material on site. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section.

3.05 BORROW SITES

Upon completion of borrow operations, clean up borrow areas as indicated on Construction Drawings in neat and reasonable manner to satisfaction of the borrow area property owner.

3.06 RIP-RAP

- A. Place rip-rap in areas where indicated on Construction Drawings. Stone for rip-rap shall consist of field stone or rough unhewn quarry stone as nearly uniform in section as is practical. Stones shall be dense, resistant to action of air and water, and suitable for purpose intended. Unless otherwise specified, stones used as rip-rap shall weigh between 50-lb and 150-lb each, and at least 60 percent of stones shall weigh more than 100-lb each.
- B. Slopes and other areas to be protected shall be dressed to line and grade shown on Construction Drawings prior to placing of rip-rap. Undercut areas to receive rip-rap to elevation equal to final elevation less average maximum dimension of stones before placing rip-rap.

- C. Filter fabric and bedding stone shall be installed prior to placement of rip-rap stones if so indicated on Construction Drawings. Bedding stone shall be quarried and crushed angular limestone and shall be 6-in. in depth. Filter fabric shall be as detailed on Construction Drawings.
- D. Rip-rap shall be placed so that greater portion of weight is carried by earth and not by adjacent stones. Stones shall be placed in single layer with close joints. Upright areas of stone shall make angle of approximately 90 degree with embankment slope. Courses shall be placed from bottom of embankment upward, with larger stones being placed in lower courses. Open joints shall be filled with spalls. Stones shall be embedded in embankment as necessary to present uniform top surface such that variation between tops of stones shall not exceed 3-in.

3.07 FINISH GRADING

- A. Finish grading of all disturbed areas on utility projects shall be performed. Distrubed areas shall be returned to a condition that meets or exceeds the condition prior to the utility construction. Grade areas where finish grade elevations or contours are indicated on Construction Drawings, other than paved areas and buildings, including excavated areas, filled and transition areas, and landscaped areas. Graded areas shall be uniform and smooth, free from rock, debris, or irregular surface changes. Finished subgrade surface shall not be more than 0.10-ft above or below existing elevations or established finished subgrade elevations. Finish ditches shall be graded to allow for proper drainage without ponding and in manner that will minimize erosion potential.
- B. Correct settled and eroded areas within 1 year after date of completion at no additional expense to Owner. Bring grades to proper elevation. Replant or replace grass, shrubs, bushes, or other vegetation that appears dead, dying, or disturbed by construction activities.

End Of Section 02200

UNCLASSIFIED EXCAVATION FOR UTILITIES SECTION 02221

PART 1. GENERAL

A. The work called for by this section shall consist of clearing and grubbing, loosening, loading, removing, and disposing of, in the specified manner, all wet and dry materials (including rock) encountered that must be removed for construction purposes; furnishing, placing, and maintaining all sheeting, shoring, bracing, and timbering necessary for the proper protection and safety of the work, the workmen, the public, and adjacent property and improvements; the dewatering of trenches and other excavations; the preparation of satisfactory pipe beds; the backfilling and tampering of trenches, foundations, and other structures; the perpetration of fills and embankments; the removal of unsuitable material from outside the normal limits of excavation and, where ordered by the A/E, their replacement with suitable materials; and all other grading or excavation work incidental to or necessary for the work. This work shall be performed as specified below.

PART 2. PRODUCTS

Not used.

PART 3. EXECUTION

- 3.1 PREPARATION OF THE SITE
 - A. Before starting construction, remove from the work site all vegetable growth (except as hereinafter excluded), debris, and/or other objectable matter as well as any buildings and/or other structures that the drawings and/or the A/E specifically indicate are to be removed. Dispose of this refuse material in a manner acceptable to the A/E.
 - B. In certain areas in may be desirable for existing trees, shrubs, or other vegetation on the site to be preserved for the permanent landscape. Such vegetation may be shown on the drawings, specifically listed in the specifications, marked on the site, or identified by the A/E. In no case damage or remove such growth without written permission from the Owner.
 - C. If the area to be excavated is occupied by trees, brush, or other vegetable growth, clear such growth and grub the excavated area, and remove all large roots to a depth of not less than 2 feet below the bottom of the proposed construction. Dispose of the growth removed in a manner satisfactory to the A/E. Fill all holes or cavities created during this work that extend below the subgrade elevation with suitable material, and compact to the same density as the surrounding material.

- D. Trees, cultivated shrubs, etc., that are situated within public rights-of-way and/or construction easements through private property but not directly within the excavation area shall remain undisturbed unless it is necessary to remove them so that the work can be performed safely and unless their removal is specifically ordered by the A/E. Take special precautions to protect and preserve such growth throughout all stages of the construction.
- E. Preparation of the site shall be considered an integral part of the excavation and one for which no separate payment shall be allowed.

3.2 UNSUITABLE MATERIALS

A. Wherever muck, quicksand, soft clay, swampy ground, or other material unsuitable for foundations, subgrade, or backfilling is encountered, remove it and continue excavation until suitable material is encountered. The material removed shall be disposed in the manner described below. Then refill the areas excavated for this reason with crushed stone. The top 6 inches of this refill shall be No. 67 (TDOT) crushed stone for bedding.

3.3 ROCKS AND BOULDERS

- A. Any material that is encountered within the limits of the required excavation that cannot be removed except by drilling and/or blasting, including rock, boulders, masonry, hard pan, chert, shale, street and sidewalk pavements, and/or similar materials, shall be considered as unclassified excavation, and no separate payment will be made therefor.
- B. Should rock be encountered in the excavation, remove it by blasting or otherwise. Where blasts are made, cover the excavation with enough excavation material and/or timber or steel to prevent danger to life and property. The Contractor shall secure, at his own expense, all permits required by law for blasting operations and the additional hazard insurance required. Observe all applicable laws and ordinances pertaining to blasting operations.
- C. Excavate rock over the horizontal limits of excavation and to a depth of not less than 6 inches below the bottom of pipe up to 30 inches in diameter and not less than 12 inches below the bottom of larger pipes if rock extends to such depth. Then backfill the space below grade with No. 67 (TDOT) crushed stone or other approved material, tamp to the proper grade, and make ready for construction. For brick or monolithic concrete sewers and for structures, excavate rock to the outside bottom of the structure or sewer.

3.4 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 A/E shall be used for these purposes. Any materials not so used shall be considered waste materials and disposed of by the Contractor as specified below.
- B. Waste materials may be deposited in spoil areas at locations approved by the A/E. Do not leave in unsightly piles but instead spread in uniform layers, neatly levels, shape to drain. Seed as specified in Section 02485, Seeding.
- C. Once any part of the work is completed, properly dispose of all surplus or used materials (including waste materials) let within the construction limits of that work. Leave the surface of the work in a neat and workmanlike condition, as described below.
- D. The disposal of waste materials shall be considered an integral part of the excavation work and one for which no separate payment shall be allowed.

3.5 EXCAVATION FOR TRENCHES, MANHOLES, AND STRUCTURES

- A. Unclassified excavation for pipelines shall consist of the excavation necessary for the construction of water, sewer, and other pipes and their appurtenances (including manholes, inlets, outlets, headwalls, collars, concrete saddles, and pipe protection) that are called for by the necessary, backfilling and tamping pipe trenches and around structures, and disposing of waste materials, all of which shall conform to the applicable provisions set forth elsewhere in these specifications.
- B. The Contractor may, if he chooses, use a motor powered trenching machine. If he does, however, he shall be fully responsible for the preservation or repair of existing utility service connection.
- C. Unless the construction of lines by tunneling, jacking, or boring is called for by the drawings or specifically authorized by the A/E, make excavation for pipelines in open cut and true to the lines and grades shown on the drawings or established by the A/E on the ground. Cut the banks of trenches between vertical parallel planes equidistant from the pipe centerline. The horizontal distance between the vertical planes (or, if sheeting is used, between the inside faces of this sheeting) shall vary with the size of the pipe to be installed, but shall not be more than the distance determined by the following formula: 4/3d + 15 inches, where "d" represents the internal diameter of the pipe in inches. When approved in writing by A/E, the banks of trenches from the ground surface down to a depth not closer than 1 foot above the top of the pipe may be excavated to nonvertical and nonparallel planes, provided the excavation below that depth is made with vertical and parallel sides equidistant from the pipe centerline in accordance with the

formula given above. Any cut made in excess of the formula 4/3d + 15 inches shall be at the expense of the Contractor and may be cause for the A/E to require that stronger pipe and/or a higher class of bedding be used at no cost to the Owner.

- D. For rigid pipe, shape the bottom of all trenches to provide uniform bearing for the bottom of the pipe barrel. For plastic sewer lines, provide a minimum of 6 inches of No. 67 (TDOT) crushed stone for bedding.
- E. Excavate bell holes for bell and spigot pipe at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper jointing of the pipe. Do not excavate bell holes more than 2 joints ahead of pipe laying.
- F. Excavation for manholes, inlets, and other incidental structures shall not be greater in horizontal area than that required to allow a 2 foot clearance between the outer surface of the structure and the walls of the adjacent excavation or of the sheeting used to protect it. The bottom of the excavation shall be true to the required shape and elevation shown on the drawings. No earth backfilling will be permitted under manholes, inlets, headwalls, or similar structures. Should the Contractor excavate below the elevation shown or specified, he shall, at his own expense, fill the void with either concrete or granular material approved by the A/E.
- G. Do not excavate pipe trenches more than 200 feet ahead of the pipe laying, and perform all work so as to cause the lest possible inconvenience to the public. Construct temporary bridges or crossings when and where the A/E deems necessary to maintain vehicular or pedestrian traffic.
- H. In all cases where materials are deposited along open trenches, place them so that in the event of rain no damage will result to the work and/or to adjacent property.
- I. Excavation for manholes and other structures may be performed with nonvertical banks except beneath pavements or adjoining existing improvements. Do not permit the horizontal area of the excavation to exceed that required to allow a 2 foot clearance between the outer excavation or the sheeting used to protect the embankments. The bottom of the excavation shall be true to the required shape and elevation.

3.6 SHEETING, SHORING, AND BRACING

A. Take special care to avoid damage wherever excavation is being done. Sufficiently sheet, shore, and brace the sides of all excavations to prevent slides, cave-ins, settlement, or movement of the banks and to maintain the specified trench widths. Use solid sheets in wet, saturated, or flowing ground. All sheeting, shoring, and bracing shall have enough strength and rigidity to

withstand the pressures exerted, to keep the walls of the excavation properly in place, and to protect all persons and property from injury or damage. Separate payment will not be made for sheeting, shoring, and bracing, which are considered an incidental part of the part excavation work.

- B. Whenever employees may be exposed to moving ground or cave-ins, shore and lay back exposed earth excavation surfaces more than 5 feet high to a stable slope, or else provide some equivalent means of protection. Effectively protect trenches less than 5 feet deep when examination of the ground indicated hazardous ground movement may be expected. Guard the walls and faces of all excavations in which employees are exposed to danger from moving ground by a shoring system, sloping of the ground, or some equivalent protection.
- C. Comply with all OSHA standards in determining where and in what manner sheeting, shoring, and bracing are to be done. The sheeting, shoring, and bracing are to be done. 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 A/E. 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 sheeting, shoring, and bracing.
- D. Where excavations are made adjacent to existing buildings or structures or in paved streets or alleys, take particular care to sheet, shore, and brace the side of the excavation so as to prevent any undermining of or settlement beneath such structures or pavement. Underpin adjacent structures wherever necessary, with the approval of the A/E.
- E. Do not leave sheeting, shoring, or bracing materials in place unless this is called for by the drawings, ordered by the A/E, or deemed necessary or advisable for the safety or protection of the new or existing work or features. Remove these materials in such a manner that the new structure or any existing structures or property, whether public or private, will not be endangered or damaged and that cave-ins and slides are avoided.
- F. Fill and compact all holes and voids left in the work by the removal of sheeting, shoring, or bracing as specified herein.
- G. 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.

3.7 THE DEWATERING OF EXCAVATION

A. Provide and keep in operation enough suitable pumping equipment whenever necessary or whenever directed to do so by the A/E. Give special attention to excavations for those structures that, prior to proper backfilling, are subject to flotation from hydrostatic uplift.

3.8 BORROW EXCAVATION

- A. Whenever the backfill of excavated areas or the placement of embankments requires more material than is available from authorized excavations, or whenever the backfill material from such excavations is unsuitable, then obtain additional material from the other sources. This may require the opening of borrow pits at points accessible to the work. In such cases, make suitable arrangements with the property owner and pay all incidental costs, including any royalties, for the use of the borrowed material. Before a borrow pit is opened, the quality and suitability of its material shall be approved by the A/E.
- B. Excavate borrow pits in such a way that the remaining surfaces and slopes are reasonably smooth and that adequate drainage is provided over the entire area. Construct drainage ditches wherever necessary to provide outlets for water to the nearest natural channel, thus preventing the formation of pools in the pit area. Leave the sides of borrow pit cuts at a maximum slope of 2:1 unless otherwise directed by the A/E.
- C. Properly clear and grub borrow pits, and remove all objectionable matter from the borrow pit material before placing it in the backfill.
- D. The taking of materials from borrow pits for use in the construction of backfill, fills, or embankments shall be considered an incidental part of the work; no separate payment shall be made for this.

3.9 BACKFILLING

A. Begin backfilling after the line construction is completed and then inspected and approved by the A/E. On each side of the line, from the bottom of barrel to 1 foot above the top of the pipe, the backfill material shall consist of either fine, loose earth like sandy soil or loam or of granular material that is free from clods, vegetable matter, debris, stone, and/or other objectionable materials and that has a size of no more than 2 inches. Place this backfill simultaneously on either side of the pipe in even layers that before compaction are no more than 6 inches deep. Thoroughly and completely tamp each layer into place before placing additional layers. When shown on the drawings, this backfill shall, at locations beneath or closely adjacent to pavement, consist of No. 67 (TDOT) crushed stone.

- B. If plastic sewer pipe is used, install No. 67 (TDOT) crushed stone in a 6 inch envelope in all sides of the pipe and over the pipe. Then add remaining backfill as described in the previous paragraph.
- C. From 1 foot above the pipe upward, the backfill material may contain broken stones that make up approximately 3/4 of the backfill's total volume. However, if this type of backfill is used, there must be enough spalls and earth materials to fill all voids completely. The maximum dimension of individual stones in such backfill shall not exceed 6 inches, and the backfill material shall be placed and spread in even layers not more than 12 inches deep. At locations beneath or closely adjacent to pavement or at locations of improvements subject to damage by displacement, tamp and thoroughly compact the backfill in other areas, the backfill for the upper portion of the trenches may be placed without tamping but shall be compacted to a density equivalent to that of adjacent earth material as determined by laboratory tests. Use special care to prevent the operation of backfilling equipment from causing any damage to the pipe.
- D. If earth material for backfill is, in the opinion of the A/E, too dry to allow thorough compaction, then add enough water so that the backfill can be properly compacted. Do not place earth that the A/E considers too wet or otherwise unsuitable.
- E. Wherever excavation has been made within easements across private property, the top 1 foot of backfill material shall consist of fine loose earth free from large clods, vegetable matter, debris, stone, and/or other objectionable materials.
- F. Wherever trenches have been cut across or along existing pavement or driveways, temporarily pave the backfill of such trenches by placing Class A, Grade D, crushed stone as the top 12 inches of the backfill. Maintain this temporary pavement either until the permanent pavement is restored or until the project is accepted by the Owner.
- G. Conduct backfilling around manholes, inlets, outfalls, and/or structures in the same manner as specified above for pipelines except that even greater care is necessary to prevent damage to the utility structure.
- H. Wherever pipes have diameters of 15 inches or less, do not use power operated tampers to tamp that portion of the backfill around the pipe within 1 foot above the pipe.
- I. Perform backfilling so as not to disturb or injure any pipe and/or structure against which the backfill is being placed. If any pipe or structure is damaged and/or displaced during backfilling, open up the backfill and make whatever repairs are necessary, whenever directed to do so by the A/E.

- J. Backfilling and clean-up operations shall closely follow pipe laying; failure to comply with this provision will result in the A/E's requiring that the Contractor's other activities be suspended until backfilling and clean-up operations catch up with pipe laying.
- K. Compaction Requirements: Under buildings and 2 times the depth of pipe beyond, and under roads and 2 times the depth beyond the shoulder, compact to 95% maximum density in accordance with ASTM D698, in all other locations, compact to 90% maximum density, or backfill the trench entirely with crushed stone.

3.10 MAINTENANCE

- A. Seed and maintain in good condition all excavated areas, trenches, fills, embankments, and channels until final acceptance by the Owner.
- B. Maintain trench backfill at the approximate level of the original ground surface by periodically adding backfill material wherever necessary and whenever directed to do so by the A/E. Continue such maintenance until final acceptance of the project, or until the A/E issues a written release.

3.11 SLOPES

A. Neatly trim all open cut slopes, and finish to conform to either the slope lines shown on the drawings or the directions of the A/E. Leave the finished surfaces of bottom and sides in reasonably smooth and uniform planes like those normally obtainable with hand tools, though the Contractor will not required to use hand methods if he is able to obtain the required degree of evenness with mechanical equipment. Conduct grading operations so that material is not removed or loosened beyond slope.

END OF SECTION 02221

- 1. GENERAL
- 1.1 WORK INCLUDED
 - A. Placement of seed and mulch.
- 2. PRODUCTS

2.1 SEED MATERIALS

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

Seed Name	Quantity % by Weight
Kentucky 31 Fescue	55%
Redtop	15%
English Rye	30%

C. All seed shall meet the requirements of the Tennessee Department of Agriculture.

2.2 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	$10\% \pm 2\%$
Organic Matter	$99.4\% \pm 0.2\%$
Ash Content	$0.6\% \pm 0.2\%$
Water Hold Capacity (per hundred1050	grams minimum grams of oven dry fiber)

2.3 COMMERCIAL FERTILIZERS

A. Unless otherwise specified, inorganic 10-20-10 nitrogen, phosphoric acid, and potash for seeding and 15-15-15 or 1-1-1 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.

3. EXECUTION

3.1 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 for a depth of approximately 1/2" at the rate of:
 - 1. Not less than 20 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 1 1/2 pounds per 1000 square feet, unless otherwise specified.
- F. Do not perform seeding during windy weather, or when the ground surface is frozen, wet or otherwise nontillable. No seeding shall be performed during December through February unless otherwise permitted.

- G. 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. When wood fiber mulch is used, uniformly apply at the rate of 28 to 35 pounds per 1000 square feet with hydraulic mulching equipment.

END OF SECTION 02485
SECTION 02575 PAVEMENT REPAIR

PART 1 GENERAL

- 11 The work specified by this section shall consist of repairing or replacing all damaged pavement, whether public or private. This section does not imply that road crossings may be open cut rather than bored. Permission must be received to open cut city streets. Dirt shoulders, roads, streets, drives, and walks are to 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. Repair the entire area as specified below and as shown on the drawings or on the standard drawings. The entire street width shall be paved from the edge of the existing pavement to the edge of the existing pavement. The width of the pavement repair shall be as per Lewisburg Public Works' requirements. Where the pavement repair abuts the existing pavement, the existing pavement shall be cut in a straight line and excavated to a depth necessary to provide a smooth transition from the existing pavement surface to the new pavement surface while providing the new pavement to a thickness of 4 inches.
- 1.2 Both these specifications and the drawings 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 sections, 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.
- 1.3 Refer to other sections for items affecting paving.

PART 2 PRODUCTS

- 2.1 <u>Mineral Aggregate Base:</u> Class A, Grading D crushed stone (TDOT) specifications, (Section 303 Subsection 903.05).
- 2.2 <u>Bituminous Prime Coats:</u> Cutback asphalt, Grade RC-250, or emulsified asphalt, Grade AE-P (Section 402, Subsections 904.02 and 904.03).
- 2.3 <u>Crushed Stone Chips:</u> Size 6 or Size 7 (Subsection 903.14).

- 2.4 <u>Double Bituminous Surface:</u> for both course, either cutback asphalt, Grade RC-800 or RC-3000, or emulsified asphalt, Grade RS-2 (Subsections 904.02 and 904.03).
- 2.5 <u>Asphalt Concrete Binder:</u> Grading B (Section 307).
- 2.6 <u>Bituminous Tack Coat:</u> Grade AE-3 (Section 403, Subsection 904.03).
- 2.7 <u>Asphaltic Concrete Surface:</u> Grading E (Section 411)
- 2.8 <u>Quick Dry Traffic Paint (White and Yellow)</u>: Subsection 910.05.

PART 3 EXECUTION

3.1 SUBGRADE

- A. Before any base material is installed, compact the subgrade 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 subgrade has been prepared, test for uniformity of support by driving a loaded dump truck at a speed of 2 to 3 mph over the entire surface. Make further improvements on all areas that show a deflection of 1" or more. When completed, the finished subgrade shall be hard, smooth, stable, and constructed in reasonably close conformance with the lines, grades, and typical cross sections shown on the drawings.
- C. When a base course is compacted, cut back the surface course of the existing pavement a minimum of 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.

3.2 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 6".

3.3 SEAL COAT SURFACE

A. Uniformly apply a bituminous prime coat of either 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 size 7 crushed stone ships at a rate of 12 pounds per square yard.

3.4 DOUBLE BITUMINOUS SURFACE

- A. Apply the first course at a rate of 0.38 to 0.42 gallon per square yard with either emulsified asphalt, Grade RS-2, or cutback asphalt, Grade RC-800 or RC-3000, and then immediately cover with 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 with 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 (4) days, or as directed by the A/E. 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 broom. Sweep the surface at the time determined by the A/E.

3.5 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's 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 and asphaltic concrete binder.
- 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.

3.6 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. Take care to prevent the bituminous material's splashing on exposed faces of curbs, gutters, walls, walks, tress, 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 and width shown on the drawings. Apply the surface course as described above for the binder course.

3.7 SMOOTHNESS

A. The finished surface shall conform to the lines and grades shown on the drawings. No deviations, variations, or irregularities exceeding 1/4" in any direction when tested with a 12' straightedge will be permitted in the finished work, nor will any depression that will not drain. Correct all such defects.

3.8 SAMPLING AND TESTING

- A. Submit to the A/E 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 on 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 tests.
- C. When making surface tests, furnish one man to mark all surface defects for corrections.

END OF SECTION 02575

SECTION 02600 MANHOLES

PART 1. GENERAL

- 1.1 Manholes shall be precast with eccentric cones unless otherwise approved by the A/E.
- 1.2 Refer to other sections for items affecting manholes. Coordinate this work with that specified by other sections for timely execution.
- 1.3 Shop drawings are required for casting, plastic gaskets, manhole steps, resilient pipe connection, and precast manholes specified in this section.
- 1.4 Manholes shall be watertight and of high quality.

PART 2. PRODUCTS

- 2.1 CONCRETE MASONRY: reinforced, meeting the applicable requirements of Section 03003, Concrete for Utility Lines.
- 2.2 CLAY BRICK (FOR CASTING ADJUSTMENT): Clay brick shall be medium hard or better quality Grade MS sewer brick conforming to the requirements of ASTM C32-73. Brick shall be solid and not cored or frogged.
- 2.3 MORTAR: composed of one part portland cement and two parts sand (volumetric measure) thoroughly mixed in a tight box, with water added gradually and mixed continually until mortar has attained the proper consistency for use in brick masonry; prepared only in such quantities as needed for immediate use, mortar mixed for more than 30 minutes, retempered, or previously will not be allowed.
- 2.4 GRAY IRON CASTINGS: cast iron conforming to requirements of Class 30, ASTM A48, made accurately to the required dimensions; sound, smooth, clean, and free from blisters and other defects; not plugged or otherwise treated to remedy defects; machined so that covers rests securely in the frames with no rocking and are in contact with frame flanges for the entire perimeter of the contact surfaces; thoroughly cleaned subsequent to machining and, before rusting begins, painted with a bituminous coating so as to present a smooth finish, tough and tenacious when cold, but actual weight in pounds stenciled or printed by the manufacturer on each casting in white paint.

2.5 STANDARD FRAME AND COVER

A. The standard frame and cover shall be traffic typed gray cast iron ASTM Designation A 48-Latest Revision, with a 24 inch diameter opening. The covers shall be the solid self-sealing type with no holes except watertight pick notches. The surface between the cover and frame shall fit smoothly without rocking and shall be thoroughly cleaned.

B. Covers shall be of the solid indented type with the words "Sanitary Sewer" cast in raised letters thereon. Manhole frames and covers shall be John Bouchard Number 1150 or equal.

2.6 WATERTIGHT MANHOLES FRAMES AND COVERS

- A. The manhole frames shall be set in the same manner prescribed for standard frames except special attention shall be paid to securing a watertight connection to the manhole barrel.
- B. The watertight manhole frame and cover shall be a traffic type of grey cast iron ASTM Designation A 48-64 with a 24 inch diameter minimum clear opening weighing not less than 450 pounds and shall be of the two-cover design as shown on the Plans.
- C. The surface cover shall be the solid type with no holes except watertight pick notches or a heavy lifting ring. The surface between this cover and frame shall fit without rocking. 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 at least 7/16 inch diameter cross-section with a hollow center. The inner cover shall be mechanically sealed by means of a removable metal bar located over the inner cover with a centrally-located bronze or stainless steel tightening bolt. This bolt shall have a tee-handle or bent-handle for turning. 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 removal from the frame. The frame shall be attached to the manhole barrel by means of four ½-inch anchor bolts and shall be set in a bed of mastic so as to constitute a watertight seal between the barrel and the frame.

2.7 MANHOLE JOINT SEALANT FOR PRECAST MANHOLES

A. Flexible plastic sealant for joints in pre-cast manhole sections shall provide permanently flexible watertight joints, shall remain workable over wide temperature range and shall not shrink, harden or oxidize upon aging. Material shall be butyl resin sealant ConSeal CS-102 or CS-202 as manufactured by Concrete Sealants, Inc. of New Carlisle, Ohio, RUB'R-NEK L-T-M manufactured by K.T. Snyder Co., Inc. of Houston, Texas, or other approved equal.

2.8 MANHOLE STEPS

A. Manhole steps shall be made of copolymer polypropylene plastic meeting the latest revision of ASTM Designation D2146-82, Type II Grade 16906 and shall have a 1/2 inch diameter Grade 60 reinforcing rod meeting the latest revision of ASTM Designation A 615 through its center. Each step shall be 12 inches in width and capable of carrying 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.

2.9 MANHOLE INVERTS

- A. Manhole inverts shall be formed from 2,000 psi concrete. Inverts for "Straightthrough" manholes may be formed by laying the pipe straight through the manhole, pouring the concrete invert and then breaking out the top half of the pipe. Curved inverts shall be constructed of concrete and shall form a smooth even, half-pipe section as shown on the Plans. The inverts shall be constructed when the manhole is being built.
- B. The bench or top portion of the invert shall slope to the flow line to prevent standing water.

2.10 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 construction. Connectors shall be manufactured of durable rubber which offers superior resistance to water, sewage, oils, acid, ozone, weathering and aging. Conical type flexible which shall be clamped securely to the cut out in the manhole wall and to the pipe by means of stainless steel clamps or bands. The void area between the pipe and the connector shall be sealed with an approved flexible gasket material. Connectors shall be as manufactured by the KOR-N-SEAL Co. of Milford, N.H. or equal.
- B. Compression-type connectors cast integrally into the manhole wall shall be equivalent to the A-Lok Manhole Pipe Connector as manufactured by A-Lok Products, Inc.

2.11 PRE-CAST CONCRETE MANHOLES

- A. Precast manholes shall be constructed on a reinforced concrete foundation and shall be wet cast as modified herein. The bottom section of the manhole shall be precast integrally with the precast ring and shall be 4'-0" in diameter. All concrete used in connection with the construction of manholes shall be 4,000 psi concrete. Wet cast precast manholes shall be Cloud or equal.
- B. Precast concrete rings shall be constructed using standard forms and shall conform to ASTM Standard Specification C478 including steel reinforcement.
- C. The precast sections shall be manufactured and installed in a manner so that there is no visible leakage in the manholes. The manhole section shall be manufactured in lengths such that a finished manhole will have the least possible number of joints. One section less than four feet in length will be allowed per manhole and that being the section required to bring the manhole to grade. The precast rings shall be of the tongue and groove design sealed watertight, and the joint shall be grouted smooth on the inside and outside of the manhole so that no crack is visible. A resilient pipe connection shall be utilized in the sewer line to manhole connection.
- D. Xypex Admix C-1000 at a dosage rate of 3% by weight of cement shall be applied as an admixture to the concrete for all precast manholes. A red dye shall be applied to the concrete mix to readily identify precast manholes with the xypex admixture applied.
- E. The manhole sidewall shall be of a length such that a maximum of one course of brick shall be placed on top of the unit to bring the casting to grade. Concrete adjustment rings are required.
- F. Each manhole shall have a sewer trench check dam installed on the influent lines. The check dam shall be of 3,000 psi concrete. It shall extend a minimum of 6" under the sewer pipe and fill the entire trench and cut into the trench walls two feet into each wall. It shall be located not less than 10 feet from the face of the manhole and not more than 30 feet from the face of the manhole.

2.12 MATERIAL TESTING

A. All precast reinforced concrete manhole risers and tops specified herein shall be tested and inspected by a commercial testing laboratory approved by the A/E prior to delivery to the site, and all materials that fail to conform to these specifications shall be rejected. After delivery to the site any materials that have been damaged in transit or are otherwise unsuitable for use in the work shall be rejected and removed from the site. Supply certified copies in duplicate of the inspection and acceptance reports of the testing laboratory to A/E before using the materials. The commercial testing laboratory shall be engaged and paid for by the Contractor. Submit a certificate from the manufacturer of the castings indicating that they meet all applicable requirements of these specifications.

PART 3. EXECUTION

- 3.1 Dewater sufficiently to maintain the ground water level at or below the bottom of the manhole foundation prior to and during placement of the foundation.
- 3.2 Obtain an adequate foundation for all manhole structures by removing and replacing unsuitable material with well graded granular material, by tightening with coarse rock, or by such other means as provided for foundation preparation of the connected sewers or as directed by the A/E. Wherever water is encountered at the site, place all cast in place bases or monolithic structures on a one-piece waterproof membrane to prevent any movement of water into the fresh concrete.
- 3.3 When the foundation subgrade has been prepared and is approved by the A/E, carefully construct the concrete foundation for monolithic manholes to the line and grade required by the drawings. Construct the manholes after the concrete foundation has been allowed to set for a period of not less than 24 hours.
- 3.4 For precast manholes, carefully block the base section above the prepared surface so that it is fully and uniformly supported in true alignment; make sure that all entering pipe can be inserted at proper grade. Then place the concrete foundation and invert under and upon this base section as shown in the standard drawings. A base section with monolithic foundation (bottom) may be used when approved by the A/E.
- 3.5 Thoroughly wet and then completely fill all holes with non-shrink grout.
- 3.6 Construct monolithic concrete manholes and bases of 4,000 psi concrete in accordance with the provisions of this section. The manhole steps shall be cast in place.
- 3.7 Carefully set the cast iron frame for the cover at the required elevation, and properly bond it to the masonry with cement grout and/or anchor bolts. Wherever manholes are constructed in paved areas, tilt the top surface of the frame and cover so as to conform to the exact slope, crown, and grade of the existing adjacent pavement.

- 3.8 Manhole inverts shall be constructed of concrete or mortared masonry fill and may, at the Contractor's option, be covered with cement mortar to the approximate cross section of the sewers connected to them. Make any necessary changes in cross sections gradually from side to side of the manhole. Make changes in direction of flow of the sewers to a true curve as large a radius as is permitted by the size of the manhole.
- 3.9 All rigid unreinforced pipe entering or leaving the manhole shall be provided with flexible joints within 12 inches of the manhole structure, or encase the full joint in particularly in the area of the manhole excavation, which is normally deeper than excavation for sewer trenches. Take special care to see that the openings through which pipes enter the structures are completely firmly rammed full of non-shrink grout or otherwise constructed to ensure a watertight connection.
- 3.10 Where the difference in the invert elevation of two or more sewers intersecting in one manhole is 24 inches or more, construct a drop manhole. Drop manholes shall be similar in connection of pipe and fittings of the proper sizes and materials shall be constructed outside the manhole and supported by 3,000 psi concrete.
- 3.11 Place backfill by hand around the manhole and to a distance of at least one pipe length into each trench, and tamp the selected material up to an elevation of 12 inches above the crown of all entering pipes. Continue backfilling in accordance with the requirements for trench backfilling.
- 3.12 Vacuum testing of manholes
 - A. This test is only applicable to precast concrete manholes.
 - B. All lifting holes and exterior joints shall be filled and pointed with an approved non-shrinking mortar.
 - C. Manholes are to be tested immediately after assembly and before backfilling. No standing water shall be allowed in the manhole excavation which may affect the accuracy of the test.
 - D. All pipes and other openings into the manhole shall be suitably plugged in such a manner as to prevent displacement of the plugs while the vacuum is drawn.
 - E. Installation and operation of vacuum equipment and indicating devices shall be in accordance with equipment specifications and instructions provided by the manufacturer.
 - F. The test head may be placed in the cone section of the manhole. The rim-cone joint is not usually tested.
 - G. A vacuum of 10 inches of mercury shall be drawn. The time for the vacuum to drop to 9 inches of mercury shall be recorded.

SECTION 02600 (CONT.)

H. Acceptance for 4 ft. diameter manholes shall be defined as when the time to drop to 9 inches of mercury conforms to the table below. Contractor shall keep a log of all tests which shall be submitted to the Engineer for approval.

<u>Manholes Depth</u>	Diameter	<u>Time to Drop 1" Hg</u>	
10 ft. or less	4 ft.	60 seconds	
10 ft. to 15 ft.	4 ft.	75 seconds	
15 ft. to 25 ft.	4 ft.	90 seconds	

- I. For manholes 5 ft. in diameter, add an additional 15 seconds and for manholes 6 ft. in diameter, add an additional 30 seconds to the time requirements for four foot diameter manholes.
- J. If the manhole fails to test, necessary repairs shall be made and vacuum test repeated until the manhole passes the test.
- K. If the manhole joint mastic or gasket is displaced during the vacuum test, the manhole shall be disassembled and the seal replaced.

END OF SECTION 02600

SECTION 02601 MANHOLE REPAIRS

Part 1. GENERAL

- 1.1 Repair manholes at the various locations indicated by the drawings and specifications. Manhole repairs shall consist of one or more of the following:
 - A. Raising the manhole frame and cover
 - B. Replacing the existing manhole frame and cover
 - C. Sealing the manhole (e.g., walls and bench) and invert with or without root control.
 - D. Plugging stubouts, overflows, and storm drains
 - E. Replacing manholes
- 1.2 Shop drawings are required for all products specified in this section.
- PART 2. PRODUCTS

2.1 MORTAR

A. Mortar shall be composed (by volumetric measure) of 1 part Portland cement to 2 parts sand. Thoroughly mix the sand and cement in a tight box, and gradually add clean, fresh water. Continue mixing until the mortar has the proper consistency for use in brick masonry. Prepare only as much mortar as needed for immediate use at any one time. Do not use mortar that has been mixed for more than 30 minutes, has been retempered, or has already set.

2.2 OTHER PRODUCTS

See section 02600

PART 3. EXECUTION

- 3.1 Replacing, raising, or resting manhole frame.
 - A. The existing frame and cover shall be removed and returned to the owner. The new frame and cover shall be as specified in Section 02600.
 - B. Excavation for replacement in pavement.

The removal of the manhole frame and cover shall be accomplished by making a square cut in the pavement four (4) by four feet.

All material in the 4' x 4' space to a depth to expose the entire frame and cover shall be dug out and disposed of properly off site.

Crushed stone shall be tamped in place to form the sub-base for the pavement.

MANHOLE REPAIRS, Cont'd

The pavement used to cover the exposed area, i.e., concrete or asphalt surfacing, plus base, shall conform to the existing pavement in that street. It shall be compacted and placed to the same elevation and grade as the existing pavement.

All pavement replacements not satisfactorily done by the contractor shall be reworked at no expense.

- C. Excavation for Replacement in Non-Paved Areas
 - 1. No unnecessary excavation of materials from around the manholes shall be done.
 - 2. Backfill shall be replaced and compacted to prevent settlement and to restore the site to an equal or better condition than found. Backfill not to cover the manhole.
 - 3. Any private property which has to be removed for access to the manhole shall be replaced by the contractor in the same or better condition than found.
- 3.2 Manhole Replacement
 - A. The manholes shown on the Plans or directed by the Engineer shall be replaced. The materials and method of construction shall be in accordance with Section 02600. Extreme care shall be exercised by the Contractor to insure that the existing sewer lines are not damaged when the existing manhole is removed. Any damage to existing sewer lines shall be repaired by the contractor at no additional cost to the owner.
- 3.3 Plugging and Sealing Stub-Outs, Overflow, and Storm Drains
 - A. Stub-outs, and overflows shall be plugged inside the manhole using brick stacked and mortared so as to form a solid wall. Stub-outs shall be plugged prior to manhole sealing and sealed with manhole sealant.
 - B. Storm/surface drains shall be plugged at the point of entry into the line (Storm/surface drains catch basin) whenever possible. The storm/surface drains shall also be plugged in the manhole following the same method as for stub-outs.
 - C. The internal plugging of manhole connections shall be included in the sealing of manhole wall and/or inverts.

MANHOLE REPAIRS, Cont'd

- 3.4 Sealing of Manholes, Inverts, and Bench
 - A. The sealing of manholes, inverts, and benches in an effort of rehabilitation of existing manholes shall be performed in accordance with Section 02602.
- 3.5 Testing of Manhole Repairs and Replacement Manholes
 - A. Following the required manhole rehabilitation or replacement, the manhole shall be tested by the Contractor in the presence of the engineer and/or his representative after all necessary curing has taken place.
 - B. All manholes that are repaired as described in this section shall be tested unless states otherwise by the Engineer.
 - C. Manholes shall be vacuum tested in accordance with Section 02600.
 - D. All manholes which fail the test shall be corrected at no additional cost.

END OF SECTION 02601

PART 1. GENERAL

1.1 These specifications are intended to set a standard of quality and design for the application of all cementitious materials used in the rehabilitation of manholes.

PART 2. PRODUCTS

2.1 INFILTRATION CONTROL

- A. All fast setting materials furnished shall be designed to be applied in dry powder form, with no prior mixing of water, directly to active leaks under hydrostatic pressure in manholes or related structures. Materials shall consist of rapid setting cements, silicios gypsum, or metallic particles. Infiltration control materials shall be Quadex Hydra-Plug,as manufactured by Quadex, Inc., Little Rock, Arkansas, or approved equal.
- B. Infiltration control materials shall meet the following minimum specifications:
 - 1. Compressive Strength (ASTM C109) 30 mins: 1850 psi / 28 days: 5890 psi
 - 2. Bond Strength (ASTM C321) 30 mins: 50 psi / 1 day: 85 psi
 - 3. Set Time: 30 seconds

2.2 INVERT REPAIR AND PATCHING

- A. All material furnished shall be designed to fill large voids in manhole walls and to repair or reconstruct inverts where no hydrostatic pressure exists. Material shall consist of rapid setting cements, NSG aggregates, and various accelerating agents. Material shall not contain chlorides, gypsum, or metallic particles. Invert repair and patching material shall be Quadex Hyperform, or approved equal.
- B. Invert repair and patching materials shall meet the following minimum specifications:
 - 1. Compressive Strength (ASTM C109) 1 hour: 4,170 psi / 24 hours: 7,000 psi
 - 2. Flexural Strength (ASTM C348) 1 hour: 450 psi / 24 hours: 600 psi
 - 3. Freeze-Thaw (ASTM C666) 300 cycles with no damage
 - 4. Setting Time (Gilmore ASTM C266) Initial 15-18 minutes / Final 22-25 minutes

2.3 CEMENTITIOUS COATING MATERIAL FOR MANHOLE WALLS AND BENCHES

A. All cementitious coating materials shall be specifically designed for the rehabilitation of manholes and other related wastewater structures. Liner materials shall be cement based, poly fiber reinforced, shrinkage compensated,

and enhanced with chemical admixtures and silicious aggregates. Liner materials shall be mixed with water per manufacturer's written specifications and applied using equipment specifically designed for either low pressure spray or centrifugal spin casting application of cement mortars. All cement liner materials must be capable of a placement thickness of $\frac{1}{2}$ " to 4" in a one pass monolithic application.

- B. All cementitious coating materials shall be approved for use based upon the following design conditions:
 - 1. Low to mild hydrogen sulfide environments (pH > 3.0)

Cementitious coating materials shall be manufactured from Type II Portland cement, and enhanced with silica fume. Materials shall contain poly fiber reinforcement, chemical admixtures, and silicious aggregates. Material shall be Quadex QM-1s Restore, or approved equal.

2. Extremely harsh hydrogen sulfide environments (pH < 3.0)

Cementitious coating materials shall be manufactured from 100% pre calcium alminate cement and enhanced with high density chemically stable aggregates. Materials shall contain poly fiber reinforcement and chemical admixtures. Material shall be Quadex Aluminaliner, or approved equal.

- C. All cementitious coating materials shall conform to the following 28-day minimum physical properties:
 - 1. Compressive Strength (ASTM C109) 9,000 psi
 - 2. Flexural Strength (ASTM C293) 1,100 psi
 - 3. Permeability (AASHTO T-277) Not to exceed 400 coulombs
 - 4. Freeze-Thaw (ASTM C666) No damage in minimum 300 cycles
 - 5. Material Wet Density Minimum 127 +/- 5 PCF

PART 3. EXECUTION

3.1 MANHOLE CLEANING AND PREPARATION

- A. The floor and interior walls of the manhole shall be thoroughly cleaned and made free of all foreign materials including dirt, grit, roots, grease, sludge and all debris or material that may be attached to the wall or bottom of the manhole.
- B. High pressure water blasting with a minimum of 3,500 psi shall be used to clean free all foreign material within the manhole.
- C. When grease and oil are present within the manhole, an approved detergent or muriatic acid shall be used integrally with the high pressure cleaning water.

- D. All materials resulting from the cleaning of the manhole shall be removed prior to application of the cement based coating.
- E. All loose or defective brick, grout, ledges, steps and protruding ledges shall be removed to provide an even surface prior to application of cement based coating.

3.2 SEALING ACTIVE LEAKS

- A. The work consists of hand applying a dry quick-setting cementitious mix designed to instantly stop running water or seepage in all types of concrete and masonry structures. The applicator shall apply material in accordance with manufacturer's recommendations and following specifications.
- B. The area to be repaired must be clean and free of all debris per the guidelines set forth in Section 3.1.
- C. Once cleaned, prepare crack or hole by chipping out loose material to a nimimum depth and width of ³/₄ inch.
- D. With gloved hand, place a generous amount of the dry quick-setting cementitious material to the actie leak, with a smooth fast motion, maintaining external pressure for 30 seconds, repeat until leak is stopped.
- E. Proper application should not require any special mixing of product or special curing requirements after application.

3.3 INVERT REPAIR

- A. The work consists of hand mixing and applying a rapid setting, high early strength, non-shrink patching material to fill all large voids and repair inverts prior to spray lining of the manhole. For invert repairs, flow must be temporarily restricted by inflatable or mechanical plugs prior to cleaning.
- B. The area to be repaired must be cleaned and free of all debris per the guidelines set forth in Section 3.1.
- C. Mix water shall be clean potable water and require no additives or admixtures for use with cementitious patching materials.
- D. Cementitious material shall be mixed in a mortar tub or 5 gallon pail with water per manfacturer's specifications. Material should be mixed in small quantities, to avoid setting prior to placement in voids or inverts.
- E. Once mixed to proper consistency, the materials shall be applied to the invert or void areas by hand or trowel. In invert applications, care should be taken not to apply excessive material in the channel, which could restrict flow. Once applied, materials should be smoothed either by hand or trowel in order to facilitate flow.

F. Flows in inverts can be re-established within 30 minutes of material placement.

3.4 APPLICATION OF CEMENTITIOUS MANHOLE LINER

- A. The work consists of spray applying and/or centrifugally spin casting a cementitious based liner to the inside of the existing manhole. The necessary equipment and application methods to apply the cementitious based liner materials shall be only as approved by the material manufacturer.
- B. Material shall be mixed with water in accordance with manufacturer's specifications. Once mixed to proper consistency, the materials shall be pumped via a rotor-stator style progressive cavity pump through a material plaster hose for delivery to the appropriate and/or selected application device.
- C. Material hose shall be coupled to a low-velocity spray application zozzle. Pumping of the material shall commence and the mortar shall be atomixed by the introduction of air at the nozzle, creating a low-velocity spray pattern for material application.
- D. Spraying shall be performed by starting at the manhole invert and progressing up the wall to the corbel and chimney areas.
- E. Material shall be applied to a uniform thickness no less than 2 inches. Material shall be applied to the bench area in such a manner as to provide for proper drainage without ponding.

F. Centrifugal spin casting application of the cementitious material shall be as follows:

- 1. Material hose shall be coupled to a high speed rotating applicator device. The rotating casting applicator shall then be positioned within the center of the manhole at either the top of the manhole chimney or the lowest point elevation corresponding to the junction of the manhole bench and walls.
- 2. The high speed rotating applicator shall then be initialized, and pumping of the material shall commence. As the mortar begins to be centrifugally cast evenly around the interior of the manhole, the rotating applicator head shall be raised and/or lowered at a controlled retrieval speed conducive to providing a uniform material thickness on the manhole walls.
- 3. Controlled multiple passes are then made until the specified minimum finished thickness is attained. If the procedure is interrupted for any reason, simply arrest the retrieval of the applicator head until flows are recommenced.

- 4. Material thickness may be verified at any point with a depth gauge and shall be no less than a uniform 2 inches. If additional material is required at any level, the rotating applicator head shall be placed at that level and application shall recommence until that area is thickened.
- G. Material shall be applied only when manhole is in a damp state, with no visible water dripping or running over the manhole walls.
- H. The low-velocity spray nozzle and the centrifugal spin casting head may be used in conjunction to facilitate uniform application of the mortar material to irregularities in the contour of the manhole walls and bench areas.
- I. Troweling of materials shall begin immediately following the spray application. Initial troweling shall be in an upward motion, to compress the material into voids and solidify manhole wall. Precautions should be taken not to overtrowel.
- J. Curing will take place once the manhole cover has been replaced. It is important that the manhole cover is replaced no more than 10-20 minutes after troweling is complete to avoid moisture loss in the material due to sunlight and winds.
- K. Material shall not be applied during freezing weather conditions. Material shall not be placed when the ambient temperature is 37 degrees Fahrenheit and falling or when the temperature is anticipated to fall below 32 degrees Fahrenheit during 24 hours.

3.5 TESTING OF MANHOLE REPAIRS AND REPLACEMENT MANHOLES

- A. Following the required manhole rehabilitation or replacement, the manhole shall be tested by the Contractor in the presence of the engineer and/or his representative after all necessary curing has taken place.
- B. All manholes that are repaired as described in this section shall be tested unless states otherwise by the Engineer.
- C. Manholes shall be vacuum tested in accordance with Section 02600.

All manholes which fail the test shall be corrected at no additional cost.

END OF SECTION 02602

SECTION 02722 GRAVITY SEWER

1. <u>GENERAL</u>

- A. Pipe material for sewer lines 18" and smaller shall be PVC unless otherwise directed.
- B. Pipe material for sewer lines 24" and larger shall be reinforced concrete, PVC, or ductile iron. Ductile iron pipe shall be used only when indicated on the drawings.
- C. Shop drawings are required for all products specified in this section.
- D. Refer to other sections for items affecting gravity sewers. Coordinate this work with that specified by other sections for timely execution.

2. <u>PRODUCTS</u>

- 2.1 <u>Pipe</u>
 - A. <u>Reinforced Concrete</u>: pipe with an internal diameter of 24" and larger or more are to be reinforced concrete pipe conforming to the requirements of ASTM C76, Class IV with Wall Thickness B, unless otherwise authorized by the A/E in writing; circular concrete pipe with elliptical reinforcements are not acceptable.
 - B. <u>Polyvinyl Chloride (PVC)</u>: to meet and/or exceed the requirements of ASTM D3034, SDR 26, suitable for use as a gravity sewer conduit with provisions for contraction and expansion at each joint; with rubber ring and standard lengths of 20' and 12.5' plus or minus 1"; designed to pass all tests at 73°F (plus or minus 3°F); 6" long sections of pipe to be subjected to impact from a free falling tup (20 pounds, type A) in accordance with ASTM D2444 with no evident splitting or shattering (denting not considered a failure); and with a minimum envelope of 6" of granular material around and over the pipe, but with all other bedding and backfilling requirements remaining the same as for other pipe material. PVC pipe shall not be used where industrial wastes are present.
 - C. <u>Ductile Iron</u>: pipe shall be of at least Pressure Class 350, Cement Lined. All pipe, fittings excepted, may be slip joint (push-on) type. This class pipe is to be used where the sewer crosses a street, crosses under a water line with less than 18 inches of clearance, under a parking or storage lot, or in any other location where high compression stresses from loads above ground might reasonably be expected. For industrial waste applications, ductile iron pipe with a Protecto 401 lining shall be used.
 - D. <u>Lateral Branches</u>: to be tees of the same material as the main sewer have a 6" inside diameter unless otherwise specified or noted; able to withstand all test pressure involved without leakage.

2.2 Joints and Jointing Materials

- A. <u>Concrete Pipe Joint</u>: O-ring conforming to the requirements of ASTM C443; shape and design submitted to the A/E for his approval in writing; gaskets to meet the recommendations of the gasket manufacturer; joints designed to meet the infiltration requirements of these specifications.
- B. <u>Polyvinyl Chloride (PVC) Pipe Joints</u>: joints for sewer plastic pipe shall meet all requirements of ASTM D3212 standard specifications. 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 defection. Pipe and fittings shall have integral bell with elastometric seal joint.
- C. <u>Ductile Iron Pipe Joints</u>: gasket type joints for bell and spigot ductile iron pipe designed to meet the infiltration requirements of these specifications; jointing to comply with the applicable provisions of ANSI A21.11.

2.3 <u>Compression Coupling</u>

When dissimilar pipe materials like PVC and concrete pipe are joined, use compression couplings that are resistant to the corrosive action of soils and sewage and that will provide a permanent watertight joint. The compression couplings shall be of natural or synthetic rubber or rubber-like material and shall comply with the requirements and test methods specified in Table 2 of ASTM C425. The coupling shall meet the leak requirements specified in ASTM C425, and the bands for attaching the couplings to the dissimilar pipes shall be of stainless steel meeting ASTM A167 or A240. Each coupling shall bear the manufacturer's identifying mark and an indication of its size.

2.4 <u>Meter Box</u>

Each service clean out shall be protected by a HDPE meter box, green, with a hinged HDPE cover, with "SEWER" printed on the cover. The clean out box shall be model 1419 as manufactured by Carson-Brooks Plastics, of Glendora California (1-800-735-5566) or approved equal.

2.5 <u>Service Assembly</u>

2.5.1 The typical residential sewer service assembly will consist of the following:

- a. Meter box with clean-out
- b. Service line, 4" PVC, SDR 26 or Schedule 40
- c. Wye on sewer main
- d. 2" x 4" or 4" x 4" by 4'-0' long Creosote or Perma-Treated sewer marker set flush with the ground surface marking the end of any stubbed service lines.
- e. Plug the end of any unconnected service line and cleanout.
- f. Grade of service line to be 1/8" per foot, minimum.
- g. Minimum cover to be 18 inches.

3. <u>EXECUTION</u>

3.1 <u>Pipe Laying</u>

For new sections of sanitary sewer from manhole (new or existing) to manhole (new or existing).

- A. Lay no pipe except in the presence of an inspector representing the A/E.
- B. Before placing sewer pipe in position in the trench, carefully prepare the bottom and sides of the trenches, and install any necessary bracing and sheeting as provided in Section 02221, Unclassified Excavation for Utilities.
- C. Wherever necessary to provide satisfactory bearing surface, place concrete cradles as shown on the drawings or as directed by the A/E. Cradles shall be of concrete.
- D. Tightly stretch a mason's line or wire above ground level, parallel to and directly above the axis of the pipe to be installed, supporting this line at intervals of no more than 50' for sewers being laid on a grade of 2% or more and of no more than 25' for grades of less than 2%. Determine the exact line and grade for each section of pipe by measuring down from this line to the invert of the pipe in place, and accurately place each pipe to the exact line and grade called for on the drawings. Furnish all labor and materials necessary for erecting batterboards.

- E. Laser may be used after the type and procedures are approved by the A/E. When lasers are used, set reference points for both line and grade at each manhole. Where grades are 0.6% or less, check the elevation of the beam each 100' with an offset point or engineer's level.
- F. Do not allow water to run or stand in the trench while pipe laying is in progress or before the trench has been backfilled. Do not at any time open up more trench than the available pumping facilities are able to dewater.
- G. Correct trench bottoms found to be unsuitable for foundations after pipe laying operations have started, bringing them to exact line and grade with crushed stone as necessary (see section 02221).
- H. Carefully inspect each piece and special fitting before it is placed, and lay no defective pipe in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade. When pipe laying is not in progress, keep the ends of the pipe tightly closed with an approved temporary plug.
- I. Bell holes shall be large enough to allow ample room for the pipe joints to be properly made. Cut out bell holes no more than 2 joints ahead of the pipe laying. Carefully grade the bottom of the trench between bell holes so that each barrel rests on a solid foundation for its entire length. Lay each pipe joint so as to form a close concretic joint with adjoining pipe and to avoid sudden offsets or inequalities in the flow line.
- J. Before constructing or placing any joints, demonstrate to the A/E, by completing at least one sample joint, that the methods to be used conform to the specifications and will provide a watertight joint and further that the workmen to be involved in this phase of work are thoroughly familiar and experienced with the type of joint proposed.
- K. No other type of joint may be used unless authorized in writing by the A/E.
- L. Install tee branches in sewer lines to serve properly each lot facing or abutting on the street or alley in which sewer is being laid and at such other locations as may be designated by the A/E. If tee branches are not to be used immediately, close them with approved stoppers that are held in place to prevent infiltration and withstand all test requirements.
- M. For all tees that are plugged and laid in rock, blast a minimum of 6 LF of ditch line in the direction and to the approximate grade of the future lateral as directed by the A/E, but do not excavate the material. This shall be done at no extra cost to the Owner. Furnish the A/E with a record of the exact location of each tee installed.

- N. If the work consists of constructing a new sewer to replace an existing one, connect existing service lines to the new line.
- O. New service laterals shall conform to the standard drawings.
- P. As the work progresses, thoroughly clean the interior of the pipe in place. After line of pipe has been laid, carefully inspect it, and remove all earth, trash, rags, and other foreign matter from its interior.
- Q. After the joints have been completed, they shall be inspected, tested, and accepted by the A/E before being covered. The pipe shall meet the test requirements for watertightness; immediately repair any leak or defect discovered at any time after completion of the work. Any pipe that has been disturbed after joints were formed shall be taken up, the joints cleaned and remade, and the pipe relaid at the Contractor's expense. Carefully protect all pipe in place from damage until backfilling operations are completed.
- R. Do not begin the backfilling of trenches until the pipe in place has been inspected and approved by the A/E.
- S. Lay sewers at least 10' horizontally from any existing or proposed water main. If this is not practical, the sewer may be laid closer than 10' to a water main provided it is laid in a separate trench and the elevation of the of the sewer is at least 18" below the bottom of the water main.
- T. Where a sewer crosses under water mains, the top of the sewer shall be at least 18" below the bottom of the water main. If the elevation of the sewer cannot be varied to meet the above requirements, relocate the water main to provide this separation, or else reconstruct it with mechanical joint ductile iron pipe for a distance of 10' on each side of the sewer with a full joint of water main centered over the sewer.
- U. If it is impossible to obtain proper horizontal and vertical separation as stipulated above, construct both the water main and the sewer of mechanical joint ductile iron pipe, and pressure test each.
- V. Perform boring by means of augering to the size, line, and grade shown on the drawings. Jack the steel casing pipe into place as the boring proceeds. Weld sections of casing pipe together to provide a watertight joint.
- W. Make connections to all existing sewer lines as shown on the drawings or as directed by the A/E. Make connections either by removing a section of the sewer from the existing line and inserting a wye or tee branch of the proper size or by constructing a manhole, junction box or regulator chamber.

SECTION 02722 (CONT.)

- X. Make connections to existing manholes or inlets by cutting a hole in the wall of the existing structure, inserting a length of sewer pipe into the hole, filling around the pipe with concrete or mortar, and trowling the inside and outside surfaces of the joint to a neat finish. Shape or reshape the bottom of the manholes as necessary to fit the invert of the sewer pipe.
- Y. Joint dissimilar pipe by using suitable compression couplings. If compression couplings are not available, make jointing with a special fabricated coupling approved by the A/E.
- Z. Provide concrete protection or concrete cap as shown on the drawings for pipe sewers that, when completed, have less than 2.5' of covering in nontraffic areas and 4' of cover in traffic areas.
- AA. Carefully protect from damage all existing sewers, water lines, gas lines, sidewalks, curbs, gutters, pavements, electrical lines, and other utilities or structures in the vicinity of the work at all times. If it is necessary to repair, remove, and/or replace any such utility or structure in order to complete the work properly, so in compliance with the provisions set forth in other sections of these specifications. Any such work shall be considered incidental to the construction of pipe sewers, and no additional payment will be allowed thereof.
- BB. Water service connections will be repaired or replaced by the Contractor at his expense as an incidental part of the work.
- CC. Service or house connections to existing sewers that are damaged or removed shall be repaired or replaced by the Contractor at his own expense as an incidental part of the work.
- DD. All testing of concrete pipe and materials will be made by a commercial testing laboratory. Before beginning work, furnish the A/E with the name of the pipe materials supplier. No pipe shall be delivered to the job site which does not bear the testing laboratory's stenciled or other marked sign of acceptance. Furnish the A/E with 2 certified copies of the testing laboratory's report of inspection, testing, and acceptance on all pipe and specials.
- EE. For PVC and ductile iron, furnish a certificate from the pipe manufacturer indicating that the pipe meets all applicable requirements of these specifications.
- FF. Reinforced concrete pipe, furnish a certificate by and meet the requirements of the Permeability Test and Hydrostatic Test of ASTM C14.

- GG. The minimum pipe stiffness for PVC pipe at 5% defection shall be 46 for all sizes when tested in accordance with ASTM D2412; external loading properties of plastic pipe shall be by parallel plate loading.
- HH. A specimen of PVC pipe 6" long shall be flattened between parallel plates in a suitable press until the distance between the plates is 40% of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is complete in 2 to 5 minutes.
- II. After being immersed for 2 hours in a sealed container of anhydrous acetone (99.5% pure), a sample ring of PVC pipe shall show no visible spalling or cracking when tested in accordance with ASTM D2152 (swelling or softening is not considered a failure).
- JJ. A locating tape shall be buried with all non-metallic sewer pipe approximately 18" above the pipe. Six inches of gravel, then 12 inches of backfilled soil will be between the pipe and tape. The tape shall be green and read "Buried Sewer Line Below".

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SEWER SIZE	ABSOLUTE MINIMUM	PREFERRED MINIMUM		
	SLOPE	SLOPE		
	(FEET/100 FEET)	(FEET/100 FEET)		
4" Service	1.00	1.25		
8" Main	0.40	0.522		
10" Main	0.28	0.387		
12" Main	0.22	0.304		

KK. Install all gravity sewer at minuimum slopes indicated below:

Engineers are expected to design sewer lines at the preferred minimum slopes indicated above where possible. Exceptions will be considered where future extensions are likely and minimum depths are being approached.

- 3.2 Partial Sewer Line Replacement and/or Point Repairs
 - A. Locate all existing underground utilities before beginning excavation.
 - B. Unless the construction of lines by tunneling, jacking, or boring is called for, make excavation for pipelines in open cut and true to the lines and grades shown on the drawings or established by the A/E on the ground. Cut the banks of trenches between vertical parallel planes equidistant from the pipe centerline. The horizontal distance between the vertical planes (or, if sheeting is used, between the inside faces of that sheeting) shall vary with the size of the pipe to be installed, but shall not be more than the distance determined by the following formula 4/3d + 15 inches, where "d"

SECTION 02722 (CONT.)

represents the internal diameter of the pipe in inches. When approved in writing by the A/E, the banks of trenches from the ground surface down to a depth not closer than 1 foot above the top of the pipe may be excavated to nonvertical and nonparallel planes, provided the excavation below that depth is made with vertical and parallel sides equidistant from the pipe centerline in accordance with the formula given above. Any cut made in excess of the formula 4/3d + 15 inches shall be at the expense of the Contractor and may be cause for the A/E to require that stronger pipe and/or a higher class of bedding be used at no cost to the Owner.

- C. Take reasonable care during the initial excavation of the defective pipe so as not to disturb existing pipe that is still acceptable. Where the specifications require the material from excavation to be wasted and the trench backfilled with crushed stone; load this material directly into trucks during excavation; do not pile on the street. After defective pipe has been exposed, uncover as much additional pipe as is necessary to allow space for workmen and the installation of the new pipe. Cut out the defective pipe in such a way that the ends are straight and smooth and free of ships or cracks. Remove the defective pipe from the trench, and excavate the former bedding material of any nature of that pipe to 6 inches below the pipe grade. All excavation is to be done in accordance with applicable portions of Section 02221, Unclassified Excavation for Utilities. Then fill the bottom of the trench with 6 inches of 1/2 inch to 3/4 inch crushed stone.
- D. Lay no pipe except in the presence of an inspector.
- E. Before placing sewer pipe in position in the trench, carefully prepare the bottom and side of the trench, and install any necessary bracing and sheeting as specified in Section 02221, Unclassified Excavation for Utilities.
- F. Wherever necessary to provide a satisfactory bearing surface, place concrete cradles as shown on the drawings or as directed by A/E.
- G. Tightly stretch a mason's line or wire above the ground level, parallel to and directly above the axis of the pipe to be installed. This line is to be supported at intervals not exceeding 50 feet on sewers being laid on a grade of 2% or more ant not exceeding 25 feet on grades of less than 2%. Determine the exact line and grade for each section of pipe by measuring down this line to the invert of the pipe in place. Accurately place each pipe to the exact line and grade called for on the drawings. Furnish all labor and materials necessary for erecting batter boards.
- H. Laser may be used after the type and procedures are approved by the A/E. When lasers are used, set reference points for both line and grade at each

SECTION 02722 (CONT.)

manhole. Where grades are 0.6% or less, check the elevation of the beam 100 feet with an off site point or Engineer's level.

- I. Do not allow water to run or stand in the trench while pipe laying is in progress or before the trench has been backfilled. Do not at any time open up more trench than available pumping facilities are able to dewater.
- J. If trench bottoms are found to be unsuitable for foundations after pipe laying operations have started, correct and bring them to exact line and grade as required by Section 02221, Unclassified Excavation for Utilities.
- K. Carefully inspect each piece of pipe special fitting before it is placed, and lay no defective pipe and in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade. When pipe laying is not in progress, keep the ends of the pipe tightly closed with a temporary plug approved by the A/E.
- L. Bell holes shall be large enough to allow ample room for pipe joints to be properly made. Cut out bell holes not more than 2 joints ahead of pipe laying. Carefully grade the bottom of the trench between bell holes so that each pipe barrel will rest on a solid foundation for its entire length. Lay each pipe joint to form a close concretic joint with adjoining pipe and so as to avoid sudden offsets or inequalities in the flow line.
- M. Before constructing or placing any joints, complete at least one sample joint in order to demonstrate to the A/E that the methods employed conform to the specifications and will provide a watertight joint, and further that the workmen intended for use on this phase of the work are thoroughly familiar and experienced with type of joint proposed.
- N. Wherever pipe materials are joined, cut the replacement pipe to a length 1 inch less than the overall length of the section being replaced. Then place the pipe in the trench, thoroughly clean the ends of existing and replacement pipe, and install the compression couplings. After installation, check the work to ensure that the replacement pipe is vertically and horizontally aligned with the existing pipe and that the compression couplings area tight and evenly fitted.
- O. As the work progresses, thoroughly clean the interior of the pipe in place. After each line of pipe has been laid, carefully inspect and remove all earth, trash, rags, and other foreign matter from the interior.
- P. After the joints have been completed, they shall be inspected before they are covered. The pipe shall meet the test requirements for watertightness; immediately repair any leak or defect discovered at any time after completion of the work. Take up any pipe that has been disturbed after

joints were formed, clean and remake the joints, and relay the pipe this shall be done at the Contractor's expense. Carefully protect all pipe in place from damage until backfill operations have been completed.

Q. Do not begin the backfilling of trenches until the pipe in place has been inspected and approved.

3.3 <u>Service Line</u>

- A. If the work consists of constructing a new sewer to replace an existing sewer, connect all existing service lines to the new line.
- B. Replace service lines from the sewer line to the property line being served by the lines as shown in the drawings. Replace the entire service line with 4" PVC or 6" PVC service line next to the existing line.
- C. When replacing service line and/or service connections to the main line, install a 4" clean out at the property line and backfill the entire area with crushed stone if it is in a paved area.
- D. Install tee branches in any sanitary sewer lines designated by the A/E. If such branches are not to be used immediately, close them with stoppers approved by the A/E that are held in place to prevent infiltration and meet all test requirements.
- E. To repair or replace a service connection which, in the judgment of the A/E, is the source of the leak, properly connect the service in conformance with the pipe manufacturer's recommendations and specifications and applicable ASTM specifications for the service connection and the installation of same. The material of the connection shall be similar to the sewer pipe it will connect to.

3.4 <u>Crossing Above Water Lines</u>

A. Where sewers cross above water lines, encase the sewer pipe with concrete for distance of 10 feet on each side of the crossing.

3.5 <u>Connections</u>

- A. Make connections to all existing sewer lines as shown on the drawings or as directed by the A/E. Make connections by removing a section of the sewer from the existing lines and inserting a tee branch of proper size into space; adding a saddle; or by construction a manhole, junction box, regulator chamber, or other structure as shown on the drawings.
- B. Make connections to existing manholes or inlets by cutting a hole in the wall of the existing structure, inserting a length of sewer pipe into the

hole, filling around the pipe with concrete or mortar, and troweling the inside and outside surfaces of the joint to a neat finish. Place a manhole coupling or gasket on the pipe before mortaring around the pipe. Shape or reshape the bottom of the manholes as necessary to fit the invert of the sewer pipe.

3.6 <u>Visual Testing of All New Gravity Sewers</u>

- A. Upon completion of the construction or earlier if the A/E deems advisable, the A/E will make a visual inspection of the sewer and construction site. Immediately repair all leaks and defects found by such inspection.
- B. In addition to general cleanup and leakage, the following standards shall be used to determine failure or defects of this project.
- C. Sewers shall be built so as to remain true to line and grade. The inclining grade of the bottom of the sewer after completion shall be such that, after flooding, the flood water drains off so that no remaining puddle of water is deeper than 1/2" on pipe 36" internal diameter or smaller and 3/4" in pipe larger than 36" internal diameter. Any section of pipe that does not comply with the specifications at any time previous to final acceptance of the work shall be replaced or re-laid at the Contractor's expense.
- D. The Contractor will be held strictly responsible that all parts of the work bear the load of the backfill. If cracks 1/100" develop in the pipe within one year from the date of final acceptance of the work, the Contractor will be required to replace, at his expense, all such cracked pipe. To this end, the Contractor is advised to purchase pipe under a guarantee from the manufacturer, guaranteeing proper service of sewer pipe under conditions established by the drawings, specifications, and local conditions at the site of the work.

3.7 <u>Hydrostatic Leakage Testing</u>

- A. The Contractor will be required to lay sewer lines so that the groundwater infiltration shall not average more than twenty five (25) gallons per twenty four (24) hours per inch of nominal diameter per mile of sewer, including manholes and plugged services and as measured in a high groundwater condition approximantely at the surface of the ground. These requirements may be applied to the entire system or may be applied to any single section of line. The more restrictive provisions set forth for specific items shall govern those items.
- B. In order to test for infiltration/inflow, the Engineer will require that the Contractor plug the open ends of all lines at a manhole so that measurements may be made at each section of the sewer line. Temporary

SECTION 02722 (CONT.)

pumps may also be required. The Contractor will be expected to locate and repair leaks even if the location of same required T.V. inspection.

C. Hydrostatic leakage testing of lines shall be performed by the Contractor in the presence of the Engineer or an authorized representative of the Owner.

3.8 <u>Air Testing for Sewers Lines That Have Been Replaced From Manhole to</u> <u>Manhole</u>

- A. Furnish all equipment, facilities, and personnel necessary to conduct the test. The test shall be observed by a representative of the Owner.
- B. Make the air test after backfilling has been completed and compacted.
- C. Conduct the air test on sections of line replaced from manhole to manhole. Point repairs consisting of replacing a portion of the sewer line are to be smoke tested.
- D. Plug all tees and ends of sewer services with flexible joint plugs or caps securely fastened to withstand the internal test pressures. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.
- E. Prior to testing, check the pipe to see that it is clean. If not, clean it by passing a full-gauge squeegee through the pipe. It shall be the Contractor's responsibility to have the pipe cleaned.
- F. 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 back pressure of any ground water that may submerge the pipe. Allow at least 2 minutes for temperature stabilization.
- G. The pipeline shall be considered acceptable when tested at an average pressure of 3.0 psi more than the average back pressure of any ground water that may submerge the pipe, if the section under test does not lose air at a rate greater than 0.0015 cfm per square foot of internal pipe surface area. Calculate the pressure drop as the number of seconds for the air pressure to drop from a stabilized pressure of 3.5 to 2.5 psi more than the average back pressure any ground water that may submerge the pipe. Calculate time as described in ASTM C828.
- H. The requirements of this specification shall be considered satisfied if the time required in seconds for the pressure to decrease from 3.5 to 2.5 psi

more than the average back pressure of any ground water that may submerge the pipe is not less than that shown in the following table:

<u>Pipe Size</u>	Time <u>in Seconds</u>
6"	42
8"	72
10"	90
12"	108
15"	126
18"	144
21"	180

ALLOWABLE AIR LOSS VALUES PER 100 LF

- I. If the pipe installation fails to meet these requirements, the Contractor shall determine at his own expense the source or sources of leakage and repair or replace all defective materials or workmanship. The completed pipe installation shall meet the requirements of this test before being considered acceptable.
- J. The recommended procedures for conducting acceptance tests are as follows:
 - 1. Clean pipe that is to be tested.
 - 2. Plug all pipe outlets with suitable test plugs, and brace each plug securely.
 - 3. Increase gauge pressure in the test by the amount of ground water pressure at the crown of the pipe.
 - 4. Add air slowly to the portion of the pipe installation being tested until the internal air pressure is raised to 4.0 psi more than the average back pressure above the crown of the pipe.
 - 5. After the above internal pressure is obtained, allow at least 2 minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
 - 6. After 2 minutes, disconnect the air supply.
 - 7. When pressure decreases to 3.5 psig either by leaking down or by bleeding down with a release valve, start the stopwatch, and determine the time in seconds that is required for the internal air pressure to reach

2.5 psig. Compare this time interval as calculated above. If the time is more than that calculated, the test shall be assumed to be acceptable.

- K. Plugs used to close the sewer pipe for the air test must be securely braced to prevent the unintentional release of a plug, which can become a high velocity projectile. Locate gauges, air piping manifolds, and valves at the top of the ground. No one shall be permitted to enter a manhole where a plugged pipe is under pressure. Four pounds air pressure (gauge) develops a force against the plug in a 12" pipe of approximately 450 pounds. Pipes more than 30" in diameter shall not be air tested because of the difficulty of adequately blocking the plugs. Provide a safety release device set to release at 10 psi between the air supply and the sewer under test.
- L. Regardless of the outcome of the tests, repair any noticeable leak.

3.9 <u>Testing of Point Repairs</u>

Plug the flow from the upstream manhole. Blow smoke into the downstream manhole for a minimum of 2 minutes. Check the point repair, connections to the existing sewer, and any new service for leaks. Repair any leaks detected.

3.10 <u>Visual Inspection of Miscellaneous Materials</u>

All material used in this project will be visually inspected by the A/E at the site for conformance to the required specifications. When reasonable doubt exists that said material meets the specifications, the A/E may require certified mill tests, samples, and/or tests by an independent laboratory or other suitable form of verification that the material meets the required specifications.

3.11 Deflection Testing for PVC Pipe

Test deflection of the pipe by passing a 9-arm pin go no-go mandrel sized to 95% of the pipe diameter of the actual pipe used with the pipe in place and covered. Make this acceptance test after backfill consolidation has occurred. The appropriate allowable deflection may be calculated using the pipe stiffness formula in ASTM D2321.

3.12 <u>Cleanup</u>

After completing each section of the sewer line, remove all debris, construction materials, and equipment from the site of the work, grade and smooth over the surface on both sides of the line, and leave the entire right-of-way in a clean, neat, and serviceable condition.

END OF SECTION 02722

SECTION 02724 SEWAGE FORCE MAIN

PART 1 GENERAL

- 1.01 Furnish all material, equipment, tools and labor in connection with the sewage force main complete and in accordance with the drawings and these specifications.
- 1.02 It shall be the contractor's responsibility to ensure that all necessary materials are furnished to him and that those found to be defective in manufacture are replaced at no extra cost to the owner. Materials damaged in handling after being delivered by the manufacturer shall be replaced at the Contractor's own expense. If installed material is found to be defective before the final acceptance of the work, the cost of both the material and labor needed to replace it shall not be passed on to the Owner.
- 1.03 The Contractor shall be responsible for safely storing material needed for the work that has been accepted by him until they have been incorporated into the completed project. Keep the interiors of all pipes, fittings, and other accessories free from dirt and foreign matter at all times.
- 1.04 Refer to other sections for work related to that specified by this section. Coordinate this work with that required by other sections for timely execution.

PART 2 PRODUCTS

2.01 PVC PIPE

- A. All plastic pipe shall be made from Class 12454-B polyvinyl chloride plastic (PVC 1120) as defined by ASTM D1784.
- B. All Class 200, 250, or 315, SDR 21 pipe shall have NSF approval and be manufactured in accordance with ASTM D2241. The following tests shall be run for each machine on each size and type of pipe being produced, as specified below:
 - 1. <u>Flattening Test</u>: once per shift in accordance with ASTM D2412. Upon completion of the test, the specimen shall not be split, cracked, or broken.
 - 2. <u>Acetone Test (Extrusion Quality Test)</u>: once per shift in accordance with ASTM D2152. There shall be no flaking,

peeling, cracking, or visible deterioration on the inside or outside surface after completion of the tests.

3. <u>Quick Burst Test</u>: once per 24 hours in accordance with ASTM 5199

Minim	um B	ursting					
<u>SDR</u>	Pressure Rating		Pressure, PSI				
13.5	315	1,200	17	250	1,000 21	200	800

- 4. <u>Impact Tests</u>: for 6" and larger once per shift in accordance with ASTM D2444: for 4" and smaller, once each 2 hours in accordance with ASTM D2444.
- 5. <u>Wall Thickness and Outside Dimensions Tests</u>: once per hour in accordance with ASTM D2122.
- 6. <u>Bell Dimensions Test</u>: once per hour in accordance with ASTM D3139.
- C. If any specimen fails to meet any of the above-mentioned tests, all pipe of that size and type manufactured between the test periods must be scrapped and a full set of tests rerun.
- D. Furnish a certificate from the pipe manufacturer stating that he is fully competent to manufacture PVC pipe of the uniform texture and strength and in full compliance with these specifications and further stating that he has manufactured such pipe and done so in sufficient quantities to be certain that it will meet all normal field conditions. In addition, the manufacturer's equipment and quality control facilities to be adequate to ensure that each extrusion of pipe be uniform in texture, dimensions, and strength. Also furnish a certificate from the manufacturer certifying that the pipe furnished for this project meets the requirements of these specifications.
- E. All pipe shall be manufactured in the United States of America. All pipe for any one project shall be made by the same manufacturer.
- F. All 4" and 6" pipe may be furnished in the manufacturer's standard laying lengths of 20', 38', or 40'. Pipe 8" and larger shall be furnished in 20' lengths. The Contractor's methods of storing and handling the pipe shall be approved by the A/E. All pipe shall be supported within 5' of each end; in between the end supports, there shall be additional supports at least every 15'. The pipe shall be stored away from heat or direct sunlight. The practice of stringing pipes out along the proposed line route will not be allowed.

- G. Certain information shall be applied to each piece of pipe. At the least, this shall consist of:
 - 1. Nominal Size
 - 2. Type of material
 - 3. SDR or class
 - 4. Manufacturer
 - 5. NSF Seal of Approval
- H. Pipe that fails to comply with the requirements set forth in these specifications shall be rejected.
- I. The pipe shall have push-on joints designed with grooves in which continuous molded rubber ring gaskets can be placed. Gaskets shall be made of vulcanized natural or synthetic rubber; no reclaimed rubber will be allowed. The gasket shall be of manufacturer's standard design dimensions and of such size and shape as to provide a positive seal under all combinations of joint and gasket tolerance. 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.
- J. The spigot end of each pipe shall be beveled so that it can be easily inserted into the gasket joint, which in turn shall be designed so that the spigot end may move in the socket as the pipe expands or contracts. The spigot end shall be striped to indicate the distance into which it is to be inserted into the socket. Each joint shall be able to accommodate the thermal expansions and contractions experienced with a temperature shift of at least 75 degrees F.
- K. Enough lubricant shall be furnished with each order to provide a coat on the spigot end of each pipe. This lubricant shall be nontoxic, impart no taste or smell to the water, have no harmful effect on the gasket or pipe material, and support no bacterial growth. The lubricant containers shall be labeled with the manufacturer's name.
- L. Joints shall be manufactured in accordance with ASTM D3139 except that the thickness of the bell shall be, as a minimum, equal to that of the barrel. Joints shall be either integral bell and ring joints with rubber compression gaskets as manufactured by the Clow Corporation, Johns-Manville, or Vulcan Plastic Corporation; twin gasket couplings as manufactured by the Certain-Teed Products Corporation; or equal. However, the pipe and bell must be made by the same manufacturer.
- M. Standard and special fittings shall be gray iron or ductile iron. Use standard mechanical joint fittings. All fittings shall conform to the specifications of ANSI A21.10/AWWA C110. The gaskets shall be ducked tipped transition gaskets for use with PVC pipe.
- N. Fittings shall be lined with enameline or thin cement lining as specified in ANSI A21.4/AWWA C104; this lining is to be furnished at no extra cost. In addition, a bituminous seal coat or asphalt emulsion spray coat approximately 1 mil thick shall be applied to the cement lining in accordance with the pipe manufacturer's standard practices.
- O. Fitting laying lengths shall conform to ANSI A21.10/AWWA C110.
- P. Fittings shall be in accordance with the standard mechanical joint fittings manufactured by the U.S. Pipe and Foundry Company, American Cast Iron Pipe Company, Clow Corporation or equal.

2.02 DUCTILE IRON PIPE AND FITTINGS

- A. Ductile cast iron pipe shall be made of good quality ductile iron that meets the requirements for modular iron castings of ASTM E8. It shall be plain end ductile iron pipe with push-on, single gasket joints. The wall thickness of the pipe shall be Class 51.
- B. Ductile iron pipe shall be centrifugally cast in metal or sand-lined molds and shall conform to the specifications of ANSI A21.51/AWWA C151. It shall be made and tested in accordance with ASTM A339 and shall be subjected to and able to withstand a hydrostatic pressure of 500 psi. The maximum depth of pits shall be half that allowed in the AWWA specifications.
- C. The length of each individual piece of ductile iron pipe shipped must be plainly marked on that piece of pipe.
- D. The push-on, single gasket joints shall be either Fastite (manufactured by American Cast Iron Pipe Company), Tyton (U.S. Pipe and Foundry Company), Super Bell Tite (Clow Corporation), or other joints of similar type and equal quality. They shall be UL approved and able to withstand 200 psi of operating pressure.
- E. The bell of each pipe shall have a tapered annular opening and a cast or machined retaining groove for the gasket. The gasket groove shall have a flared design so that maximum deflection will be provided. The plain spigot end of the pipe shall be beveled in

order to simplify its entry into and centering within the bell and the compression of the gasket

- F. The gasket shall be of high quality vulcanized rubber made in the form of a solid ring to exact dimensions. The design of the gasket groove in the bell of the pipe and the design, hardness, and other properties if the gasket itself shall be such that the joint is liquid-tight for all pressures from a vacuum to a maximum rating of 350 psi internal liquid pressure.
- G. Enough lubricant shall be furnished with each order to provide a thin coat on the spigot end of each pipe. This lubricant shall be nontoxic, impart not taste or smell to the water, and have no harmful effect on the rubber gasket. It shall have a consistency that will allow it to be easily applied to the pipe in either hot or colds weather and that will enable to adhere to either wet or dry pipe.
- H. Standard and special fittings shall be ductile iron. Use standard mechanical joint fittings. All fittings shall conform to the specifications of ANSI A21.10/AWWA C110.
- I. Pipe and fittings shall be lined with enameline or a thin cement lining as specified in ANSI A21.10/AWWA C104. In addition, a bituminous seal coat or asphalt emulsion spray coat approximately 1 mil. thick shall be applied to the cement lining in accordance with the pipe manufacturer's standard practices.
- J. Fitting laying lengths shall conform to ANSI A21.10/AWWA C110, short body.
- K. Fittings shall be in accordance with the standard mechanical joint fittings manufactured by the US Pipe and Foundry Company, American Cast Iron Pipe Company, Clow Corporation, or equal.
- L. The pipe manufacturer is to furnish the Engineer a certificate of inspection, sworn to by the factory inspector on the presence of a notary public, stating that the pieces of pipe in the shipment were made and tested in accordance with ANSI A21.51 and that they were subjected to and withstood a hydrostatic pressure of 500 psi. Each statement is to give the number of pieces of pipe in the shipment, the length of each pieces of pipe, and the serial number of each piece of pipe making up the shipment. In addition, the weight of each individual piece of pipe making up the shipment. In addition, the weight of each individual piece of pipe making up the shipment is to be listed and attached to the certificate of inspection.

PART 3 EXECUTION

3.01 INSTALLATION OF FORCE MAIN

- A. Lay the force main to keep it at the lines and grades required by the drawings. All fittings shall be at the required locations, and spigots well centered in the bells. Where the grades are 0.2% or less, either use batterboards or a laser to maintain the required slopes.
- B. Unless otherwise indicated by the drawings, all force main shall have at least 30" of cover. The pipe shall slope continuously between high and low points and have a minimum of 60" cover at the high points. Where applicable, force main may be placed in the same trench as the gravity sewer main that is to be installed as part of this project. No departure from this policy shall be except at the order of the A/E.
- C. Provide and use tools and facilities that are satisfactory to the A/E and that will allow the work to be done in a safe and convenient manner. Use a derrick, ropes, or other suitable equipment to lower all pipe and fittings into the trench one piece at a time. Carefully lower each piece so that neither it nor any protective coating or lining it may have will be damaged. Under no circumstances, drop or dump force main materials into the trench.
- D. Lower no pipe and fittings into the trench until they have been swabbed to remove any mud, debris, etc., that may have accumulated with them. After the pipe has been lowered, remove all unnecessary materials from it. Before any pipe is laid, brush wipe clean the outside of its spigot end and the inside of its bell and ensure that the pipe is dry and oil-free.
- E. Take every precaution to keep foreign material from getting into the pipe while it is being placed in the line. If the crew laying the pipe cannot put it into the trench and in place without allowing earth to get inside it, then place a heavy, tightly woven canvas bag of suitable size over each end of the pipe and leave it there until it is time to connect that pipe to the one adjacent to it.
- F. Place no debris, tools, clothing, or other materials in the pipe during laying operations.
- G. After a length of pipe has been placed in the trench, center the spigot end in the bell of the adjacent pipe, and then insert to the depth specified by the manufacturer and bring to the correct line and grade. Secure the pipe in place by tamping an approved backfill material around it.

- H. Bell holes shall be big enough so that there is ample room for the pipe joints to be properly made. Between bell holes, carefully grade the bottom of the trench so that each pipe barrel will rest on a solid foundation for its entire length.
- I. Whenever pipe laying is not in progress, close the open ends of pipe in the trench with a watertight plug or by other means approved by the A/E. Caulk the joints of any pipe in the trench that cannot be completed until a later time with packing in order to make them as watertight as possible; this shall be done not only at the end of each working day but also before work is stopped for lunch periods, bad weather, or any other reason. If there is water in a trench, this seat shall remain in place until the trench has been pumped completely dry.
- J. The cutting of pipe so that fittings or closure pieces can be inserted shall be done in a neat and workmanlike manner and recommendations concerning how to cut and machine the ends of the pipe in order to leave a smooth end at right angles to the pipe's axis.
- K. The flame cutting of pipe by means of an oxyacetylene torch will not be allowed.
- L. Unless otherwise directed by the A/E, lay pipe with the bell ends facing in the direction of laying.
- M. Wherever pipe must be deflected from a straight line (in either the vertical or horizontal place) in order to avoid obstructions or plumb stems, or wherever long radius curves are permitted, the amount of deflection shall not exceed that necessary for the joint to be satisfactorily made, nor that recommended by the pipe manufacturer, and shall be approved by the A/E.
- N. Lay no pipe in water or when it is the A/E's opinion that trench conditions are unsuitable. If crushed stone is used to improve trench conditions or as backfill for bedding the pipe, this shall be considered incidental to the project, and no separate payment will be made for its use.
- O. Install thrust blocks wherever the force main changes direction (e.g., at tees and bends), at dead ends, or at any other point where the manufacturer recommends and/or the A/E indicates that they are to be used.

- P. Make all joints, whether standard mechanical or push-on joints, in conformance with the recommendations of the joint manufacturer as approved by the A/E.
- Q. No. 12 copper trace wire shall be installed on all sewer force mains and appurtenances. The wire shall be installed in such a manner as to be able to properly trace all pipelines and services without loss or deterioration of signal or without the transmitted signal migrating off the tracer wire. Trace wire shall be installed in the same trench and inside bored holes and casing with pipe during pipe installation. It shall be secured to the pipe, as required, to ensure that the wire remains adjacent to the pipe. The wire shall be taped to the pipe at least every eight feet. The trace wire shall be securely bonded together at all wire joints with an approved watertight connector to provide electrical continuity, and it shall be accessible at all trace wire access points. Locator tape shall be installed 18" directly above the sewer force main. Tape shall be green and shall read "Sewer Line Located Below".

3.02 HYDROSTATIC TESTS

- A. After pipe has been laid and backfilled as specified above, subject all newly laid pipe or any valved section therefore to a pressure of 200 psi. All services are to be laid prior to testing the main and tested as part of the test of the main.
- B. The duration of each pressure test shall be at least one hour. During which time, no pressure will be lost.
- C. Slowly fill each valve section of pipe with water, and apply the specified test pressure (based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge) with a pump connected to the pipe in a manner satisfactory to the A/E. Furnish the pump, pipe, connections, gauges, and all necessary apparatus.
- D. Make all repairs necessary to any obvious leaks. Make all repairs necessary if the pipe fails the pressure test and retest the pipe. Repair and retest the pipe as many times as necessary until the pipe passes the pressure test.

END OF SECTION 02724

SECTION 02725

BORING AND CASING FOR SANITARY SEWERS

PART 1 GENERAL

1.01 GENERAL

The work to be performed hereunder shall consist of the installation of a casing pipe for the purpose of installing a sanitary sewer or water line as shown on the Drawings or as called for in these specifications. It shall include the excavation of a boring pit, auger boring between the points specified on the Drawings, furnishing and installing of the carrier pipe, and disposing of the excavated materials in the manner herein provided.

1.02 RELATED SECTIONS

- A. Section 02221 Unclassified Excavation for Utilities
- B. Section 02600 Manholes
- C. Local Governing Authority and Code Requirements
- D. Construction Drawings

PART 2 PRODUCTS

2.01 CASING PIPE

A. The casing pipe shall be of steel meeting the latest approved American Railway Engineering Association "Specifications for Pipelines for Carrying Flammable and Nonflammable Substances." The steel casing pipe shall have the minimum yield of 35,000 psi and shall have the minimum wall thickness in the following table:

TABLE OF MINIMUM THICKNESS FOR STEEL CASING PIPE FOR E72LOADING

<u>Carrier Pipe</u>	Casing Pipe	<u>Nominal Thickness</u>
³ / ₄ " - 1"	2	0.154 inch
4	8	0.250 inch
6	12	0.250 inch
8	16	0.312 inch
10	20	0.312 inch
12	22	0.312 inch
14	24	0.344 inch
16	26	0.375 inch
18	28	0.406 inch

B. When the casing pipe is installed without benefit of a protective coating inside and outside, the wall thickness shown above shall be increased to the nearest standard size, which is a minimum of 0.063 inch greater than the thickness shown.

2.02 CARRIER PIPE

- A. The carrier pipe shall be ductile iron pipe or PVC as shown on the Drawings.
- B. Joints shall be butt welded. Coatings shall be continuous at the joints.

PART 3 EXECUTION

3.01 BORING

The boring shall be accomplished by means of augering to the size, line, and grade shown on the Drawings.

3.02 INSTALLATION OF CASING PIPE

- A. Jack the steel casing pipe into place as the boring proceeds. Weld section of casing pipe together to provide watertight joints.
- B. Do not remove unacceptable casing without prior approval from the Engineer. If the removal of casing pipe is permitted, make proper provisions to prevent caving in of the earth surrounding the casing.

3.03 OPEN CUT

A. If the Contractor receives permission from the Owner of the road right-of-way, or if the casing is to be installed across a road that is not yet built, the casing may be installed by open cut trenching, in accordance with specification Section 02221.

3.04 INSURANCE

If the boring or open cut requires permission from a third party, such as a railroad, a county or state highway or road department, etc., the Contractor shall be responsible for complying with all requirements of such permits, including providing signs, flagmen, fees, and insurance policies.

End of Section 02725

SECTION 02766 RELINING SANITARY SEWERS

PART 1 GENERAL

1..1 SECTION INCLUDES

Restoration of existing sanitary sewers by installation of resin impregnated flexible felt tube inverted into the existing sewer line utilizing a vertical inversion standpipe and hydrostatic head and curing by circulating hot water or other approved means to produce a hard, impermeable pipe.

Restoration of existing sanitary sewers by installation of a polyethylene liner pipe into the existing sewer line and grouted in place to produce a continuous, watertight length between adjacent manholes.

Restoration of existing sanitary sewers by installation of a deformed polyethylene liner pipe into the existing sewer line followed by inflation to its original configuration by circulating hot water or other approved methods.

1.2 REFERENCES

A. Codes, Specifications, and Standards:

- 1. Codes, specifications, and standards referred to by number or title shall form a part of this specification to the extent required by the references thereto. Latest revisions shall apply, unless otherwise shown or specified.
- B. American Society for Testing and Materials (ASTM) Standards:
 - D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - D-1248 Specifications for Polyethylene Plastics Molding and Extrusion Materials
 - D-1693 Test for Environmental Stress-Cracking of Ethylene Plastics
 - D-2122 Determining Dimensions of Thermoplastic Pipe and Fittings
 - D-2657 Practice for Heat-Joining Polyolefin Pipe and Fittings
 - D-2837 Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
 - D-3035 Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter (up to 6" IPS)
 - D-3350 Specification for Polyethylene Plastic Pipe and Fitting Materials
 - F-585 Practice for Insertion of Flexible Polyethylene Pipe into Existing Sewers

SECTION 02766, CONT'D

F-714	Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based	
on Outside Diameter (3" IPS and larger)		

C. National Association of Sewer Service Companies (NASSCO) Standards:

NASSCO Specification - Recommended Specifications for Sewer Collection System Rehabilitation, Sixth Edition.

1.3 SUBMITTALS

- A. Submit the following:
 - 1. Manufacturer's Certificate of Compliance certifying compliance with the applicable specifications and standards.
 - 2. Certified copies of test reports of factory tests required by the applicable standards and this Section.
 - 3. Manufacturer's installation instructions and procedures.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall be responsible for the delivery, storage, and handling of products. No products shall be shipped to the job site without the approval of the Owner's Representative.
- B. Keep products safe from damage. Promptly remove damaged products from the job site. Replace damaged products with undamaged products.

1.5 STRUCTURAL INTEGRITY

The sewer section to be relined has a combination of concrete and clay and sewer pipe. A joint has separated between the clay and concrete pipes. This gap is estimated to be 3 inches ling. The manufacturer of the relining material shall provide a statement to the City of Lewisburg, signed by an officer of the manufacturer, that the relining material has sufficient structural strength to bridge a gap of this magnitude. This statement shall be submitted with the shop drawings.

PART 2 PRODUCTS

2.1 GENERAL

- A. Except as specifically stated otherwise in this Section, all products shall confirm to the applicable requirements of Section 17, Sewer Pipe Lining, of the NASSCO Specifications.
- B. The finished pipe liner in place shall be fabricated from materials which when complete is chemically resistant to and will withstand internal exposure to domestic sewage.

2.2 CURED-IN-PLACE LINER

- A. The flexible tube shall be fabricated to a size that when installed will neatly fit the internal circumference of the existing sanitary sewer lines shown on the Drawings. Allowance shall be made for circumferential stretching during insertion.
- B. The minimum length shall be that deemed necessary by the Contractor to effectively span the distance from the inlet to the outlet of the respective manholes unless otherwise shown or specified. The Contractor shall verify the lengths in the field before impregnation.
- C. Unless otherwise specified, the Contractor shall furnish a general purpose, unsaturated, polyester resin and catalyst system compatible with the reconstruction inversion process that provides cured physical strengths specified herein.
- D. Physical Strength:
 - 1. The cured pipe shall conform to the following minimum structural standards:

Flexural Stress	<u>U.S. Licensor Standard</u> #101 (Modified ASTM D790)	<u>Results</u> 4,500 psi
Flexural Modulus of Elasticity	#101 (Modified ASTM D790)	250.000 psi

2.3 DEFORMED POLYETHYLENE LINER PIPE

- A. The sewer liner pipe and fittings shall be manufactured from high density polyethylene pipe compound which conforms to ASTM D1248 and meets the requirements for Type PE34, Class C Product.
- B. Pipe made from this compound must have a long-term hydrostatic strength rating of 1600 psi or more, in accordance with ASTM D2837.
- C. When the environmental stress crack ratio resistance (ESCR) of the compound is measured in accordance with ASTM D1693, Condition C, the compound shall withstand not less than 192 hours in 100% solution Igepal CO-630 at 100 degrees F before reaching a 20% failure point (F20).
- D. Tests for compliance shall be made according to the applicable ASTM specification. A certificate of compliance with this specification shall be

SECTION 02766, CONT'D

provided by the manufacturer for all material furnished. the Owner reserves the right to witness inspection and test of the materials.

- E. The outside diameter and minimum wall thickness shall be fabricated to a size that when installed will neatly fit the internal circumference of the conduit specified by the Owner. Allowance shall be made for misaligned and missing conduit. Standard dimension ratio of liner shall be based on the flow capacity, external loads (hydrostatic pressure and/or static and dynamic earth loads), and internal pressure, if applicable.
- F. The minimum length shall be that deemed necessary by the Contractor to effectively span the distance from the inlet to the outlet of the respective manholes unless otherwise specified. The Contractor shall verify the lengths in the field before manufacturing. Individual insertion runs can be made over one or more manhole sections as determined in the field by the Engineer and approved by the Owner.
- G. The liner shall conform to the minimum structural standards for HDPE (Type III Resins) meeting ASTM D-3350-84, as listed below.

	<u>U.S. Standard</u>	<u>Results</u>
Flexural Stress (Yield)	ASTM D-638	3,300 psi
Flexural Stress (Break)	ASTM D-638	4,500 psi
Flexural Modulus of Elasticity	ASTM D-790	145,000 psi

PART 3 EXECUTION

3.1 PREPARATION

- A. The following installation procedures shall be adhered to unless otherwise approved by the Owner's representative.
 - 1. The Contractor shall carry out his operations in strict accordance with all OSHA and manufacturer's safety requirements. Particular attention is drawn to those safety requirements involving entering confined spaces.
 - 2. It shall be the responsibility of the Contractor to remove all internal debris and clean the existing sewer line prior to installation of the liner.

SECTION 02766, CONT'D

- 3. Inspection of existing sewer lines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections by closed circuit television. The interior of the line shall be carefully inspected to determine the location of any conditions which may prevent proper installation of the liner pipe into the lines, and such conditions shall be noted so they can be corrected.
- 4. The Contractor shal provide for the flow of sewage around the section or section of pipe designated for lining as specified in Section 13511.
- 5. The Contractor shall clear the line of obstructions such as solids, dropped joints, protruding service connections or collapsed pipe that will prevent the insertion of the liner pipe. If inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, then the Contractor shall make a point repair excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the Engineer, the TDOT, and the Lewisburg Public Works Department prior to the commencement of the work and shall be considered as a separate pay item.

3.2 INSTALLATION

A. Cured-In-Place Liner:

- 1. The Contractor shall designate a location where the reconstruction tube will be vacuum impregnated prior to installation. The Contractor shal allow the Owner to inspect the materials and "wet out" procedure. A catalyst system compatible with resin and reconstruction tube shall be used.
- 2. The wet out reconstruction tube shall be inserted through an existing manhole or other approved access by means of an inversion process and the application of a hydrostatic head sufficient to fully extend it to the next designated manhole or termination point. The reconstruction tube shall be inserted into the vertical inversion standpipe with the impermeable plastic membrane side out. At the lower end of the inversion standpipe, the reconstruction tube shall be turned inside out and attached to the standpipe so that a leakproof seal is created. The inversion head will be adjusted to be of sufficient height to cause the impregnated tube to invert from manhole to manhole and hold the tube tight to the pipe wall, produce dimples at side connections and flared ends at the manholes. The use of a lubricant is recommended. Care shall be taken during the elevated curing temperature so as not over stress the felt fiber.

- 3. After inversion is completed the Contractor shall supply a suitable heat source and water recirculation equipment. The equipment shall be capable of delivering hot water throughput the section by means of a prestrung hose to uniformly raise the water temperature above the temperature required to effect a cure of the resin. This temperature shall be determined by the resin/catalyst system employed.
- 4. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply. Another such gauge shall be placed between the impregnated reconstruction tube and the pipe invert at the remote manhole to determine the temperatures during cure. Water temperature in the line during the cure period shall be recommended by the resin manufacturer.
- 5. Initial cure shall be deemed to be completed when inspection of the exposed portions of cured pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm. The cure period shall be a duration recommended by the resin manufacturer, as modified for the cured-in-place inversion process, during which time the recirculation of the water and cycling of the heat exchanger to maintain the temperature continues.
- 6. The Contractor shall cool the hardened pipe to a temperature below 100 degrees F before relieving the static head in the inversion standpipe. Cool down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end. Care shall be taken in the release of the static head so that a vacuum will not be developed that could damage the newly installed pipe.
- 7. The finished pipe shall be continuous over the entire length of an inversion run and be as free as commercially practicable from visual defects such as foreign, inclusions, dry spots, pinholes and delamination. It shall also meet the leakage requirements or pressure test specified below.
- 8. If due to broken or misaligned pipe at the manhole wall, the new pipe fails to make a tight seal, the Contractor shall apply a seal at that point. The seal shall be of a resin mixture compatible with the pipe.
- 9. After the new pipe has been cured in place, the Contractor shall reconnect the existing active service connections as designated by the Owner. This shall generally be done without excavation, and in the case of nonmanentry pipe, from the interior of the pipeline by means of a television camera and a cutting device that reestablishes the service connection.

3.3 TESTING

- A. After installation of the liner, the Contractor shall perform a test on the sewer line as specified below.
- B. After installation and before any service connections are reinstated, the Contractor shal run a test on the sewer line to determine if is it is watertight.
 - 1. The Contractor shall furnish all necessary equipment to conduct the test. An acceptable method is a low-pressure air test, conducted as follows:
 - 2. Pressurize the test section to 4.0 psi and hold above 3.5 psi for not less than 2 minutes. Ass air if necessary to keep the pressure above 3.5 psi. At the end of this 2 minute stabilization period, note the pressure (must be 3.5 psi minimum) and begin the timed period. If the pressure drops 0.5 psi in less than the time given in the table below, the section of pipe shal have failed the test.
 - 3. When the prevailing groundwater is above the sewer being tested, test pressure shall be increased 0.43 psi for each foot that the water table is above the invert of the sewer.

Sewer Size (Inches)	Minimum Test Time (Minutes)
4	2
6	3
8	4
10	5
12	6
15	7.5
18	9
21	10.5
24	12
27	13.5
30	15
36	18
42	21
48	24
54	27

4. If the time for the pressure to drop 0.5 psi is 125 percent or less of the time given to the table, the line shall immediately be repressurized to 3.5 psi and the test repeated.

SECTION 02766, CONT'D

- 5. If building sewer have reinstated before the air test, they shall be considered part if the pipe to which they are connected and no adjustment of test time shall be allowed.
- 6. The pressure gauge used shall be supplied by the Contractor and have minimum division of 0.10 psi.
- C. The watertightness of the curved-in-place liner shall be gauged while curing and under a positive head.

3.4 CLEAN-UP

A. After the installation work has been completed and all testing acceptable, the Contractor shall clean up the entire project area and return the ground cover to grade. All excess material and debris mot incorporated into the permanent installation shall be disposed of by the Contractor. Sidewalks, driveways, and streets surfaces shall be restored as specified.

3.5 PATENTS

A. The Contractor shall warrant and save harmless the Owner and Engineer against all claims for patent infringement and any loss resulting therefrom.

3.6 PRIVATE SERVICE LINE SHUTDOWN

A. When it is necessary to shutdown a private service line while work is in progress and before the service lines are reconnected, the residents are to be notified by the Contractor at least one week prior to the shutdown. No service is to remain shutdown for more than a period of eight (8) hours.

END OF SECTION 02766

SECTION 02900

LANDSCAPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1. Preparation and excavation of planting beds.
- 2. Planting of trees, shrubs, sod, seed, and associated materials.

1.02 RELATED SECTIONS

- A. Section 02200 Earthwork
- B. Construction Drawings

1.03 REFERENCE STANDARDS

- A. American Association of Nurserymen, Inc. (ANA) latest version
- B. American Standard for Nursery Stock

1.04 QUALITY ASSURANCE

- A. No error or discrepancy in Construction Drawings or Specifications shall cause defective or inappropriate materials to be used or poor workmanship to be allowed.
- B. Condition of new plant materials is the responsibility of the Contractor and shall be approved by the Owner or his designated representative. The Owner or his designated representative reserves right to inspect and reject plants at any time and place.
- C. Plants shall be measured when branches are in their normal position.
- D. Trees and shrubs shall meet requirements for spread, height, or container size stated in Construction Drawings.
 - 1. Measurements are to be taken from ground level to average height of shrub and not to longest branch.
 - 2. Height and spread dimensions specified herein refer to main body of trees measured from crown of roots to tip of top branch.

- E. Caliper measurements shall be taken at point on tree trunk 6-in. above natural ground line for trees up to 4-in. in caliper, and at point 12-in. above natural ground line for trees exceeding 4-in. in caliper.
- F. If range of sizes is given, no plant shall be less than minimum size, and at least 50 percent of plants shall be as large as upper half of range specified.
- G. Measurements specified are minimum size acceptable and, where pruning is required, are measurements after pruning.

1.05 SUBMITTALS

- A. Before ordering or purchasing materials, provide samples of those materials to the Owner or his designated representative for approval, if so requested.
- B. Submit certification tags from trees, shrubs, and seed verifying type and purity.
- C. Unless otherwise authorized by the Owner or his designated representative, notify the Owner or his designated representative at least 48 hours in advance of anticipated delivery date of plant materials. Legible copy of invoice, showing kinds and sizes of materials included for each shipment, shall be furnished to the Owner or his designated representative.
- D. Inform the Owner or his designated representative of date when planting shall commence.

1.06 PROJECT CONDITIONS

Work must be carried out only during weather conditions favorable to landscape construction and to health and welfare of plants. Suitability of such weather conditions shall be determined by the Owner or his designated representative.

PART 2 PRODUCTS

2.01 PLANT MATERIALS

Plants shall conform to requirements of American Standard for Nursery Stock of rules and grading upgraded to meet the following:

- 1. Plants shall be of selected specimen quality, exceptionally heavy, symmetrical, tightly knit, so trained or favored in their development and appearance as to be superior in form, number of branches, compactness and symmetry. Plants shall have normal habit or sound, healthy, vigorous plants with well developed root system.
- 2. Plants shall be free of disease, insect pests, eggs, or larvae.

- 3. Plants shall not be pruned before delivery.
- 4. Trees with abrasion of bark, sunscalds, disfiguring knots, or fresh cuts of limbs over 1 1/4-in. which have not completely calloused shall be rejected.
- 5. Plants shall be typical of their species or variety and shall have normal habit of growth and be legibly tagged with proper name. Plants shall have been grown under climatic conditions similar to those of site or have been acclimated to such condition for at least 2 years.
- 6. Root system of each plant shall be well provided with fibrous roots. Parts shall be sound, healthy, vigorous, well-branched, and densely foliated when in leaf.
- 7. Plants designated ball and burlap must be moved with root systems as solid units with balls of earth firmly wrapped with burlap and comply with the following:
 - a. Diameter and depth of balls of earth must be sufficient to encompass fibrous root feeding systems necessary for healthy development of plant.
 - b. No plant shall be accepted when ball of earth surrounding its roots has been badly cracked or broken preparatory to or during process of planting. Balls shall remain intact during all operations.
 - c. Plants that cannot be planted at once must be heeled-in by setting in ground with root balls covered with soil or mulch and then watered as required.
 - d. Hemp burlap and twine is preferable to treated materials. If treated burlap is used, twine shall be cut from around trunk and burlap shall be removed.
- 8. Trunk of each tree shall be a single trunk growing from single unmutilated crown of roots. No part of trunk shall be conspicuously crooked as compared with normal trees of same variety.
- 9. Thickness of each shrub shall correspond to trade classification "No.1". Single stemmed or thin plants shall not be accepted. Side branches must be generous, well-twigged, and plant as whole well-branched to ground. Plants must be in moist condition, free from dead wood, bruises, or other root or branch injuries.

2.02 TOPSOIL

- A. Natural, friable, fertile, fine loamy soil possessing characteristics of representative topsoil in the vicinity which produces heavy growth.
- B. Topsoil shall be free from subsoil, objectionable weeds, litter, sods, stiff clay, stones larger than 1-in. in diameter, stumps, roots, trash, toxic substances, or any other material which may be harmful to plant growth or hinder planting operations.
- C. Verify amount of topsoil stockpiled and supply any additional as needed.

2.03 FERTILIZER

- A. Fertilizer shall be delivered, mixed as specified, in original unopened standard size bags showing weight, analysis and name of manufacturer. Containers shall bear manufacturer's guarantee statement of analysis or manufacturer's certificate of compliance covering analysis shall be furnished to the Owner or his designated representative. Store fertilizer in such manner that it shall be kept dry.
- B. Percentages of nitrogen, phosphorus, and potash shall be based on laboratory test recommendations as approved by the Owner or his designated representative. For bidding assume 10 percent nitrogen, 6 percent phosphorus, and 4 percent potash by weight. At least 50 percent of total nitrogen shall contain no less than 3 percent water-insoluble nitrogen. At least 60 percent of nitrogen content shall be derived from super-phosphate containing not less than 18 percent phosphoric acid or bone meal containing 25 30 percent phosphoric acid and 2 3 percent nitrogen. Potash shall be derived from muriate of potash containing 55 60 percent potash.

2.04 PEAT MOSS

- A. Peat moss shall be Michigan peat moss or approved equal, similar in color and consistency.
- B. Peat moss shall be moss peat, finely shredded to pass 1/2-in. mesh and shall be no less than 90 percent organic material by weight, with ash content by ignition of no more than 10 percent.
- C. Material shall contain 35 to 66 percent moisture by weight, but shall have water-holding capacity of 150 to 200 percent.
- D. Material shall have pH value of 4 to 5.
- E. Material may be imported supplied in bales or domestic furnished in bulk. If furnished in bulk, material and it's source must be acceptable to the Owner or his designated representative.

2.05 SHREDDED HARDWOOD BARK MULCH

Mulch shall be of sufficient character as not to be easily displaced by wind or water runoff.

2.06 STAKING MATERIAL

- A. Stakes shall be 8-ft steel tee posts. Three stakes shall be used for each tree.
- B. Wire used for tree staking shall be pliable No. 12 galvanized soft steel wire.
- C. Hose shall be 2-ply fibre-bearing rubber garden hose, not less than 1/2-in. inside diameter, black or green, and of suitable length.

2.07 WATER

On-site water shall be furnished by Owner. Hose and other watering equipment shall be furnished by Contractor.

2.08 LAWN SEED

Lawn seed mixture shall be fresh, clean new crop seed. Furnish to the Owner or his designated representative the dealer's guarantee statement of composition of mixture and percentage of purity and germination of each variety.

2.09 WEED MAT

Weed mat shall be "Dewitt Weed Barrier" or approved equal.

2.10 STEEL EDGING

Steel edging shall be 1/8-in. x 4-in. interlocking steel edge, staked with metal stakes sufficiently to hold in place.

2.11 STONE MULCH

Size and color of stone mulch shall be as shown on Construction Drawings.

2.12 SOD

Sod shall be species recommended by experienced local ANA certified nursery. Sod shall be strongly rooted and weed, disease, and pest free and uniform in thickness.

2.13 EROSION CONTROL BLANKET

Provide and install where indicated on Construction Drawings "Curlex" blankets by American Excelsior Company, "Polyjute" Style 465 GT by Synthetic Industries, or approved equal.

PART 3 EXECUTION

3.01 PREPARATION

- A. If project completion date prohibits in-season planting, prepare for out-of-season seeding or sodding so that lawns shall be completed and ready for acceptance at time of project completion, without additional cost to Owner.
- B. Provide sufficient tools and equipment required to carry out planting operation.
- C. Locations containing unsuitable subsoil shall be treated in one or more of the following:
 - 1. Where unsuitability is deemed by the Owner or his designated representative to be due to excessive compaction caused by heavy equipment and where natural subsoil is other than AASHTO classification of A6 or 7, loosen such areas with spikes, discing, or other means to loosen soil to condition acceptable to Owner or his designated representative. Soil shall be loosened to minimum depth of 12-in. with additional loosening as required to obtain adequate drainage. Contractor may introduce peat moss, sand, or organic matter into the subsoil to obtain adequate drainage. Such remedial measures shall be considered as incidental, without additional cost to Owner.
 - 2. Where unsuitability is deemed by the Owner or his designated representative to be due to presence of boards, mortar, concrete, or other construction materials in sub-grade and where natural subsoil is other than AASHTO classification of A6 or 7, remove debris and objectional material. Such remedial measures shall be considered as incidental, without additional cost to Owner.
 - 3. Where unsuitability is deemed by the Owner or his designated representative to be because natural subsoil falls into AASHTO classification of A6 or 7 and contains moisture in excess of 30 percent, then installation of sub-drainage system or other means removing excess moisture shall be used. Where such conditions have not been known or revealed prior to planting time and they have not been recognized in preparation of Construction Drawings and Specifications, the Owner or his designated representative shall issue a change order to install proper remedial measures.
- C. Planting operations shall be performed at a steady rate of work unless weather conditions make it impossible to work. No plant material shall be planted in frozen ground.
- E. Disk, drag, harrow, or hand rake subgrade to a depth of 3-in. to provide bond for topsoil. Topsoil which must be transported across finished sidewalks or paving

shall be delivered in such manner that no damage will be done to sidewalks or paving. Contractor shall be responsible for repair of such damage.

- F. Place no topsoil until subgrade has been approved in accordance with Section 02200. Before placing topsoil, rake subsoil surface clear of stones, debris, and roots. Compact topsoil to form layer with minimum depth of 4-in. in lawn areas and 12-in. in shrub beds. Topsoil shall be placed so that after final settlement there will be good drainage conforming to elevations shown on Construction Drawings.
- G. Tree and Shrub Preparation
 - 1. Bare rooted shrubs shall be dug with adequate fibrous roots. Roots of these plants shall be covered with uniformly thick coating of mud by being puddled immediately after they are dug, or packed in moist straw or moss.
 - 2. Ball and burlap plants shall be dug with firm natural balls of earth of diameter and depth to include adequate fibrous roots.
 - 3. Roots or root balls of plants shall be adequately protected at all times from sun and drying winds.
 - 4. Ball and burlap plants which cannot be planted immediately upon delivery shall be set on ground and shall be well protected with soil, wet moss, or other acceptable material. Bare rooted plants which cannot be planted immediately shall be heeled-in and root systems covered with soil or mulch and then watered as required.
 - 5. Bundles of plants shall be opened and plants separated before roots are covered. Care shall be taken to prevent air pockets among roots. During planting operations, bare roots shall be covered with canvas, hay, or other suitable material. No plant shall be bound with wire or rope at any time so as to damage bark or break branches.
- H. Seed Bed Preparation
 - 1. Grade seed bed areas to finish grades, filling as needed or removing surplus material such that areas are smooth and to uniform grade as indicated on Construction Drawings. Lawn areas shall slope to drain.
 - 2. Where no grades are shown, areas shall have smooth and continual grade between existing or fixed controls, such as walks, curbs, catch basin, steps, or building, and elevations shown on Construction Drawings. Roll, scarify, rake, and level as necessary to obtain true, even lawn surfaces. Finish grades shall meet approval of the Owner or his designated representative, before grass seed is sown.

- 3. Loosen soil to depth of 6-in. in lawn areas by approved method of scarification and grade to remove ridges and depressions. Remove stones or foreign matter over 2-in. in diameter from top 3-in. of soil. Grade lawn areas to finish grades.
- 4. Seed beds shall be permitted to settle or should be firmed by rolling before seedings are made.
- I. Sod Bed Preparation: Grade areas to finish grade less the root system thickness of sod, filling as needed or removing surplus material, stones, debris, etc. Grade areas to a smooth and uniform grade as indicated on Construction Drawings. Lawn areas shall slope to drain.
- J. Grass or sodded areas shall have fertilizer applied in two applications with a thorough watering as specified in Section 4.02 B, immediately following each application. The first application shall be one week prior to seeding/sodding at the rate of 25 pounds per 1000 square feet and harrowed into the top two inches of topsoil. The second application shall be at the rate of 10 pounds per 1000 square feet immediately following the second mowing.

3.02 PROTECTION

- A. Before commencing work, trees and shrubs which are to be saved must be protected from damage by placement of fencing flagged for visibility or some other suitable protective procedure approved by the Owner or his designated representative. No work shall begin until this requirement is fulfilled.
- B. In order to avoid damage to roots, bark, or lower branches, no truck or other equipment shall be driven or parked within drip line of any tree that is to be saved, unless tree overspreads paved area.
- C. Use precautionary measures when performing work around trees, sidewalks, fences, pavements, utilities, and other features either existing or previously installed.
- D. Adjust depth of earthwork and topsoil when working immediately adjacent to trees to be saved in order to prevent disturbing tree roots, undermining sidewalks and pavements, and damage in general to other features either existing or previously installed.
- E. Plants transported to project in open vehicles shall be covered with tarpaulins or other suitable covers securely fastened to body of vehicle to prevent injury to plants. Closed vehicles shall be adequately ventilated to prevent overheating of plants. Evidence of inadequate protection following digging, carelessness while in transit, or improper handling or storage shall be cause for rejection. Plants shall be kept moist, fresh, and protected. Such protection shall encompass entire period during which plants are in transit, being handled, or are in temporary storage.

- F. Where excavation, filling, or grading is required within the dripline of trees that are to remain, work shall be performed as follows:
 - 1. Trenching: When trenching occurs around trees to remain, tree roots shall not be cut but trench shall be tunneled under or around roots by careful hand digging without injury to roots.
 - 2. Raising Grades:
 - a. Where fill not exceeding 16-in. is required, clean, washed gravel graded from 1-in. to 2-in. in size shall be placed directly around tree trunk. Gravel shall extend out from trunk on all sides a minimum of 18-in. and finish approximately 2-in. above finished grade at tree. Install gravel before any earth fill is placed. New earth fill shall not be left in contact with trunks of trees requiring fill.
 - b. Where fill exceeding 16-in. is required, a dry laid tree well shall be constructed around trunk of tree. Tree well shall extend out from trunk on all sides minimum of 3-ft and to 3-in. above finish grade. Coarse grade rock shall be placed directly around tree well to a depth of 6-in., and extending out to drip line of tree. Clean, washed gravel graded from 1-in. to 2-in. in size shall be placed directly over coarse rock to depth of 3-inches. Approved backfill material shall be placed directly over washed gravel to desired finish grade.
 - 3. Lowering Grades: Existing trees in areas where new finish grade is to be lowered shall have regrading work done by hand to elevation indicated on Construction Drawings. Roots as required shall be cut cleanly 3-in. below finished grade and scars covered with tree paint.
 - 4. Trees marked for preservation that are more than 6-in. above proposed grades shall stand on broad rounded mounds and be graded smoothly into lower level. Trees located more than 16-in. above proposed grades shall have dry laid stone wall or other retaining structure as detailed on Construction Drawings constructed minimum of 5-ft from trunk. Exposed or broken roots shall be cut clean and covered with topsoil.

3.03 TREE AND SHRUB PLANTING

- A. Plants too large for 2 men to lift in and out of holes shall be placed with sling. Do not rock trees in holes to raise.
- B. If rock or other underground obstruction is encountered, the Owner or his designated representative may require plant pits to be relocated, pits enlarged, or plants deleted from project.

- C. Adjustments in locations shall be made as directed by the Engineer. In event that pits or areas for planting are prepared and backfilled with topsoil to grade prior to commencement of lawn operations, they shall be so marked that when planting proceeds, they can be readily located. In case underground obstructions such as ledges or utilities are encountered, location shall be changed under direction of the Owner or his designated representative without charge.
- D. Holes for trees shall be at least 2-ft greater in diameter than spread of root system and at least 6-in. deeper than root ball. Holes for shrubs and vines shall be at least 12-in. greater in diameter than spread of root system and at least 2-ft deep.
- E. During backfilling of tree holes and shrub beds with topsoil, manure, ground limestone if soil tests indicate it is needed, and commercial fertilizer at rate of 3-lb for trees up to 3-in. in caliper, 1-lb/in. caliper for larger trees, 6-oz for small shrubs and 8-oz for each shrub 4-ft or over shall be added as progress of work permits. Ground limestone and manure shall be omitted in case of acid soil plants. Manure, limestone, and fertilizer shall be thoroughly mixed with topsoil in planting operation, care being taken that manure does not come in immediate contact with roots.
- F. Plants shall be planted in center of holes and at same depth as they previously grew. Topsoil shall be backfilled in layers of not more than 8-in. and each layer watered sufficiently to settle before next layer is put in place. Loam shall be tamped under edges of balled plants. Enough topsoil shall be used to bring surfaces to finish grade after settlement has occurred.
 - 1. Saucer shall be provided around each plant as shown on Construction Drawings.
 - 2. Plants shall be soaked with water twice within first 24 hours after time of planting. Water shall be applied with low pressure so as to soak in thoroughly without dislodging topsoil.

3.04 MISCELLANEOUS INSTALLATIONS

- A. Stone Mulch
 - 1. Install stone mulch as shown on Construction Drawings.
 - 2. Adjust grades allowing for 4-in. thickness of stone mulch by cutting or filling. Assure slight pitch from structures. Rake surface smooth and even and roll or tamp so that the subgrade is uniformly firm.
 - 3. Lay 3 mil sheets of "Visqueen" type polyethylene on compacted subgrade before placing stone mulch with minimum overlap of 6-inches. Perforate sheeting in plant beds before placing stone mulch.
- B. Shredded Hardwood Bark Mulch

- 1. Shredded hardwood bark mulch or approved equal shall be used as 4-in. top dressing in planting beds. Single trees or shrubs shall be mulched to outside edge of saucer.
- 2. Weed mat shall be placed under planting areas not to be seeded, or as directed on Construction Drawings. Mat shall be covered with mulch and secured in place with soil anchor.
- C. Peat moss shall be used for planting soil mixture only and not be used as mulch, except on ground cover.
- D. Apply fertilizer to grass or sodded areas in 2 applications with thorough watering immediately following each application. First application shall be 1 week before seeding at rate of 35-lb/1,000 sq. ft harrowed into top 2-in. of seed bed. Second application shall be done at rate of 25-lb/1,000 sq. ft, immediately following second mowing.
- E. Sodded slopes greater than 3:1 shall be pegged to hold sod in place until sod is adequately stabilized by root system.
- F. Areas to be covered with erosion control blankets shall be properly prepared, fertilized, and seeded before blanket is applied. When blanket is unrolled, netting shall be on top and fibers in contact with soil. In ditches blanket shall be applied in direction of flow of water. On slopes, blankets shall be applied vertically on slope. Ends and sides shall be butted snugly and stapled. Staple to manufacturer's recommendations.

3.05 SEEDING

- A. Seeding shall not be performed in windy weather.
- B. Seeding shall be done in 2 directions at right angles to each other.
- C. Lawn areas shall be seeded by sowing evenly with approved mechanical seeder at rate of minimum of 3-lb/1,000 sq. ft. Culti-packer or approved similar equipment may be used to cover seed and to form seed bed in 1 operation. In areas inaccessible to culti-packer, seeded ground shall be lightly raked with flexible rakes and rolled with water ballast roller. After rolling, seeded areas shall be lightly mulched with wheat straw.
- D. Surface layer of soil for seeded areas must be kept moist during germination period. Water seeded areas twice first week to minimum depth of 6-in. with fine spray and once per week thereafter as necessary to supplement natural rain to equivalent of 1-in. or to 6-in. depth.
- 3.06 SOD

- A. When indicated on Construction Drawings, a 1'-6" wide strip shall be sodded along sidewalks, roadways, and parking areas to prevent washing and erosion.
- B. Sod shall be cut and laid on same day and only healthy, vigorous, growing sod will be acceptable.
- C. Always lay sod across slope and tightly together so as to make solid area.
- D. Roll or firmly but lightly tamp new sod with suitable wooden or metal tamper sufficiently to set or press sod into underlaying soil.
- E. After sodding has been completed, clean up and thoroughly moisten newly sodded areas.

3.07 MAINTENANCE DURING CONSTRUCTION

- A. Maintenance shall begin immediately after planting. Plants shall be watered, mulched, weeded, pruned, sprayed, fertilized, cultivated, and otherwise maintained and protected until acceptance. Settled plants shall be reset to proper grade and position, planting saucer restored, and dead material removed. Stakes and wires shall be tightened and repaired. Defective work shall be corrected as soon as possible after it becomes apparent and when weather and season permit.
- B. Lawns shall be maintained for at least 30 days after sodding and 60 days after seeding, or as long as is necessary to a establish uniform stand of the specified grasses, or until substantial completion of project, or until acceptance of lawns, whichever is later.
- C. In event that lawn operations are completed too late in the fall season for adequate germination and/or growth, maintenance shall continue into the following growing season or until a uniform stand of specified grasses has been established.
- D. Make weekly inspections to determine moisture content of soil and adjust watering schedule established by irrigation system installer to maintain proper moisture conditions.
- E. After grass growth has started, areas which fail to show uniform stand of grass for any reason whatsoever shall be reseeded in accordance with Construction Drawings and as specified herein. Such areas shall be reseeded repeatedly until areas are covered with satisfactory growth of grass at no additional cost to Owner.
- F. Watering shall be done in such a manner and as frequently as is deemed necessary by the Owner or his designated representative to assure continued growth of healthy grass. Areas of site shall be watered in such way as to prevent erosion due to excessive quantities applied over small areas and to avoid damage to finished surface due to watering equipment.

- G. Water for execution and maintenance shall be provided by Owner at no expense to Contractor. Contractor shall furnish portable tanks, pumps, hose, pipe, connections, nozzles, and any other equipment required to transport water from available outlets and apply it to seeded areas in approved manner.
- H. Mowing of seeded areas shall be initiated when grass has attained height of 1 1/2in. to 2-inches. Grass height shall be maintained at 1-in. to 1 1/2-in. at subsequent cuttings depending on time of year. Not more than 1/3 of grass leaf shall be removed at any cutting and cutting shall not occur closer than 10 days apart.
- I. Heavy cuttings shall be removed to prevent destruction of underlying turf. If weeds or other undesirable vegetation threaten to smother planted species, such vegetation shall be mowed or, in case of rank growths, shall be uprooted, raked and removed from area by methods approved by the Owner or his designated representative.
- J. Protect seeded area from trespassing while grass is germinating. Furnish and install fences, signs, barriers, or other necessary temporary protective devices. Damage resulting from trespass, erosion, washout, settlement, or other causes shall be repaired by Contractor at no expense to the Owner.
- K. Remove fences, signs, barriers, or other temporary protective devices after final acceptance.
- L. If a substantial number of plants are sickly or dead at time of inspection, acceptance shall not be granted and Contractor's responsibility for maintenance of plants shall be extended until replacements are made.
- M. Replacements shall be plants of same kind and size specified on Construction Drawings. They shall be furnished and planted as specified herein. Cost shall be borne by Contractor. Replacements resulting from removal, loss, or damage due to occupancy of project in any part, vandalism, physical damage by animals, vehicles, etc., and losses due to curtailment of water shall paid for by Owner.
- N. Remove and replace dead, defective and/or rejected plants as required before final acceptance. Replacement of plant materials that may be necessary shall be at no expense to the Owner.
- O. Grassed areas damaged during process of work shall be the responsibility of the Contractor, who shall restore disturbed areas to condition satisfactory to the Owner or his designated representative. This may include filling to grade, fertilizing, seeding, and mulching.
- P. Plants shall be guaranteed for a period of 1 year after inspection and acceptance which will be concidered the Establishment Period.

Q. At end of the Establishment Period, inspection shall be made again. Any plant that is dead or unsatisfactory to the Owner or his designated representative shall be removed from site and shall be replaced during normal planting season.

END OF SECTION 02900

SECTION 03303 CONCRETE FOR UTILITY LINES

PART 1. GENERAL

- 1.1 This item shall include furnishing and installing concrete blocking, cradles, anchors, caps, pipe protection, and/or encasement at the locations shown on the Drawings and/or as directed by the A/E.
- PART 2. PRODUCTS

NOT USED

- PART 3. EXECUTION
- 3.1 Concrete work shall conform to ACI 301-72 (as revised), as modified by the supplemental requirements below:
 - A. Strength
 - 1. The strength of concrete shall be 3,000 psi unless otherwise shown on the drawings.
 - B. Durability
 - 1. All concrete exposed to weather shall be air entrained.
 - C. Slump
 - 1. Concrete shall be proportional and produced to have a slump of 3 inches with a 1 inch tolerance.
 - D. Admixtures
 - 1. Air entrainment, mandatory for concrete exposed to weather, may be used. A water reducing admixture (retarding, normal, or accelerating, depending on placing temperature), may be used if approved by the A/E.
 - E. Reinforcing Steel
 - 1. Yield strength of reinforcing steel shall be 60,000 psi.

END OF SECTION 03303

SECTION 333213 SUBMERSIBLE WASTEWATER PUMPING STATIONS

PART 1 GENERAL

- **1.1 PACKAGED WASTEWATER PUMPING STATIONS:** pre-engineered duplex sewage pump station, including wet well/pump chamber construction, access way(s), valves, internal piping, internal wiring, controls, and other necessary components for continuous, unattended, automatic operation.
 - A. Furnish all components factory-assembled to greatest extent possible; where field installation is required, provide piping, wiring, and other components as required for a complete installation.
 - B. Configuration: wet well and access way, with pump(s) submerged in wet well, surface hatch; no above grade components.
 - C. Service life: 15 years, minimum.
 - D. Pumping capacity: _____ gallons per minute, minimum.
 - E. Total head: _____ feet.
 - F. Finish all components in accordance with manufacturer's standard practice for sewage resistance.

1.2 DIMENSIONS:

- A. Wet well inside diameter: _____ inches, minimum.
- B. Inlet and discharge sizes and elevations as indicated on drawings.
- **1.3 PUMP LIFTING ASSEMBLY:** factory-assembled, mounted in wet well, designed to allow each pump to be independently raised to ground level for maintenance and returned to position without entering wet well; vertical rails, pump support assembly sliding on rails, integral guide bracket on pump, pump quick disconnect with hydraulic sealing flange, discharge pipe supports, and lifting chain; all metal parts stainless steel.

1.4 ANCHORS AND FASTENERS: stainless steel.

1.5 IDENTIFICATION: for each item of equipment, provide the manufacturer's name or trademark and model number on corrosion-resistant identification plate, cast integrally, stamped, or otherwise permanently marked in conspicuous place; for pumps, include pump capacity in gallons per minute, pump head in feet, speed of rotation, and direction of rotation.

PART 2 PRODUCTS:

2.1 MANUFACTURER

- A. Pumps shall be Grundfos Pumps.
- B. Substitutions: submit a request for substitution for any manufacturer not named.

2.2 PUMPS

- A. 3-Phase, Sewage solids-handling pumps: non-clogging submersible centrifugal pump designed to pump unscreened sewage and capable of passing 3 inch solids.
- B. Capable of operating in fully submerged condition.
- C. Rated capacity: as indicated.
- D. Pump construction:
 - 1. Body: cast iron, designed to permit easy replacement of parts; internal passageways permitting smooth flow of sewage and free from sharp turns and projections; cleanout plates in suction line and drain plugs; all joints gasketed.
 - 2. Impellers: cast iron; free flowing, with necessary clearance to permit objects in sewage to pass; keyed, splined, or threaded onto shaft and locked in such manner that lateral movement is prevented and reverse rotation cannot cause loosening.
 - 3. Shafts: stainless steel, of size and strength required.
 - 4. Shaft sleeves: protect shaft from liquid being pumped, points in contact with stuffing boxes, and other wearing parts with sleeves of bronze or other suitable alloy.
 - 5. Shaft seals: mechanical seals of double carbon and ceramic construction with mating surfaces lapped to flatness tolerance of one light band, held in position with stainless steel spring.
 - 6. Couplings: heavy-duty flexible type couplings, keyed to the shaft; for vertical pumps provide universal type couplings.
 - 7. Balance: balance rotating parts mechanically and hydraulically to operate throughout required range without excessive end thrust, vibration, and noise; vibration not to exceed that specified in iso 1940-1, table 1; pumps dependent upon hydraulic balance are prohibited.
 - 8. Bearings: ball thrust bearings or roller type bearings of adequate size to withstand imposed loads; self-lubricating permanently sealed.

- E. Grease lubrication: manufacturer's standard grease fittings.
 - 1. Provide pump seal failure indication.
- F. Motors: hermetically sealed, direct-coupled on pump shaft in same shell; nema mg 1.
 - 1. Capacity: not less than pump at any point on pump performance curve.
 - 2. Bearings: self-lubricating permanently sealed ball or roller type main bearings to withstand radial and end thrust.
 - 3. Power cable: submersible pump cable sized for specified pump rating; seal power cable inside motor end bell.

2.3 WET WELL AND PUMP VALVE CHAMBER CONSTRUCTION

- A. Construction: concrete construction.
- B. Concrete construction: precast concrete sections complying with astm c478 (astm c478m).
 - 1. Provide a single unit comprising base, walls, and access way.
 - 2. Provide single bottom unit comprising base and walls.
 - 3. Access way may be separate unit from wet well.
 - 4. Minimum wall thickness: 5 inches.
 - 5. Concrete: 5000 psi at 28 days.
 - 6. Joint gaskets: astm c443 (astm c443m) type b.
 - 7. Exposed steel components: hot-dipped galvanized in accordance with astm a123/a123m.
 - 8. Admixtures, general: chemical type complying with astm c494/c494m (wet mix only). Zypex (3% by weight) or approved equal to be added to all wet wells.
- C. Fiberglass construction: fiberglass reinforced polyester resin of shape and design to withstand soil and external hydrostatic pressures; designed to resist hydrostatic uplift without need for concrete foundation. Fiberglass wet wells to be approved in special circumstances only.
- D. Concrete bases and foundations: provide concrete bases and foundations for equipment provided in this section if specifically required by manufacturer.
- E. Base material: crushed stone covered with polyethylene vapor barrier.

- F. Access hatch covers: aluminum with lifting mechanism, automatic hold open arm, slam lock with handle, and flush lift handle with red vinyl grip.
 - 1. Use automatic hold open arm that locks in 90-degree position.
 - 2. Construction: 1/4 inch thick diamond pattern plate with 1/4 inch channel frame and continuous anchor flange
 - 3. Live load capacity: 300 pounds per square foot
 - 4. Locking: stainless steel cylinder lock with two keys per lock; key all locks the same.
 - 5. Hatch to be water tight.

2.4 VALVES AND PIPING

- A. Valves: provide one gate valve and one check valve on each pump discharge line.
- B. Gate valves:
 - 1. Type: outside-screw-and-yoke nonrising-stem type with flanged connections; awwa c500 with double disc gates, or awwa c509.
 - 2. Provide valves with hand wheels that open by counterclockwise rotation.
 - 3. Provide with stuffing boxes that permit easy removal of parts for repair.
 - 4. Use valves from only one manufacturer.
- C. Check valves:
 - 1. Rated working pressure: 175 psi.
 - 2. Sizes 4 inches and larger: non-clogging, positive horizontal swing check type valve capable of passing 3 inch diameter solids; astm a126 cast iron body, with lever and weight.
- D. Buna-n disc and integral seat.
- E. Flanged ends: complying with awwa c110/a21.10.
- F. Removable cover for inspection and removal of gate assembly.
- G. Provide a gate valve on the gravity sewer line entering the wet well.

2.5 PIPING

A. Inlet and outlet piping: same type of pipe and jointing as specified for sanitary sewer to which pump station will be connected.

- B. Inlet and outlet piping: refer to gravity sewer and force main sections.
- C. Use flanged connections for exposed piping and mechanical connections for buried piping.
- D. Terminate discharge lines 5 feet outside wet well.
- E. Internal piping: ductile iron
 - 1. Manufacturer's standard jointing system.
 - 2. Fittings of pressure rating not less than that of pipe.
 - 3. Separate piping of dissimilar metals with rubber gasket or other approved type of insulating joint or dielectric coupling to effectively prevent metal-to-metal contact between adjacent sections of piping.
- F. Accessories: provide fittings, flanges, connecting pieces, transition glands, transition sleeves, and other adapters as required.
- G. Flexible flanged couplings: as indicated.
 - 1. Rated working pressure: 350 psi.

2.6 ACCESSORY COMPONENTS (Only if Specifically Required by Utility)

- A. Ventilation: provide exhaust blower capable of achieving complete air change every 5 minutes.
 - 1. Provide vent to atmosphere with covers and screens to prevent entrance of rain, insects, and rodents.
 - 2. Mount manual and automatic switches on inside of access way within reach from outside hatch.
- B. Dehumidifier: provide packaged dehumidifier as recommended by pump station manufacturer; include in controls humidistat and low-temperature cutout; discharge condensate to wet well.

2.7 CONTROL FUNCTIONS AND INSTRUMENTATION

- A. Automatic controls: provide automatic controls for pump and other equipment operation, with local manual controls.
 - 1. Provide manual controls as indicated.
 - 2. Provide remote indication corresponding to all local indication.
- B. Pump controls: provide controls capable of operating pumps either simultaneously or individually, depending on load conditions.

- 1. Pump actuator: submersible pressure type level sensor. One floatoperated water level switch set at high-water alarm level.
- 2. When low-water level is exceeded, start the lead pump.
- 3. Each time low-water level is reached, set the other pump as lead.
- 4. Operate both pumps if water level rises above high-water level.
- 5. Prevent both pumps from starting at the same time.
- 6. Include time delay devices so that pumps cannot be started within a certain period after shutdown, adjustable from 10 to 120 seconds.
- 7. Stop both pumps when low-water level is reached.
- 8. Provide hand-off-auto switches for each pump.
- 9. If one pump is disabled, switch operation to other pump.
- 10. Include alarm to warn of failure of pumps.
- C. Pump elapsed time meters: Icd display indicating run time in hours, not resettable; 120 volts ac.
- D. Pressure type water level sensors: 24 volt dc silicon oil-filled submersible pressure type level sensor/transmitter powered by and providing input to electronic pump controller, suspended on cable in wet well.
 - 1. Outputs: 4 to 20 ma, 2 wire, proportional to water level.
 - 2. Provide manufacturer's recommended mounting accessories.
 - 3. Select sensor range based on wet well depth.
 - 4. All exposed parts of tp316 stainless steel.
 - 5. Mounting: suspend sensor on cable inside pipe that extends from under lid of wet well to bottom of wet well.
 - 6. Mounting pipe: schedule 40 pvc, 4 inches diameter, with bottom 12 inches perforated with 3/8 inch holes spaced 1 inch
- E. Emergency high level alarm: float-operated water level switch independent of pump control; set at emergency high-water level; activating alarm indicators.
- F. No-flow switches: limit switch at check valve; indicator light; activating alarm indicators.
- G. SCADA: SCADA system to be provided as specified in Specification Section 333300.
2.8 POWER

- A. Electrical power available: Refer to local Power Company. Pumps to be 3-Phase even in Single Phase service areas.
- B. Wiring and conduit: meet or exceed requirements of nfpa 70.
- C. Control wiring: 18 awg, minimum, in plastic wireway with snap-on cover, bundled and tie wrapped neatly.
- D. Hazardous locations: where pumps are specified to be explosion proof, provide pump power and control installation that meets nfpa 70 requirements for class 1, division 1, group d hazardous location, including intrinsically safe controls, with components that are ul listed or fm approved.
- E. Control panel: nema 3r; 4x; 6, type 300 series stainless steel construction, with hinged door and hinged dead front; sized to accommodate all components; factory wired and tested.
 - 1. Internal wiring: stranded copper conductors rated at 194 degrees f, with conductor terminations as recommended by device manufacturer.
 - 2. Mounting: wall mounted, suitable for mounting on strut or channel.
 - 3. Door: minimum 180 degrees opening, rubber gasket weatherproof seal, 3-point latch, and padlockable handle.
 - 4. Back plate: steel sheet, 12 gage (0.1046 inch) thick, minimum; finished with primer coat and two coats of baked on white enamel.
 - 5. Hardware mounting: use machine screws in thread-tapped holes; sheet metal screws not permitted.
 - 6. Ventilator: rain and vermin proof ventilator of fire retardant thermoplastic, located near top of enclosure on opposite side from receptacle.
 - 7. Permanently identify all devices as they are indicated on final as-built drawings; identify on front of door and on back plate.
 - 8. Identify all control conductors with wire markers at each end as close as practical to end of conductor.
- F. Provide the following, at minimum, mounted on or in panel door:
 - 1. Alarm indication.
 - 2. Identification plate: engraved to show uppercase white letters on black background, reading:

- G. Mount the following, at minimum, on front of dead front:
 - 1. Control switches, indicator pilot lights, elapsed time meters, and other operational devices.
 - 2. Pump elapsed time meters.
 - 3. Pump seal failure indication.
 - 4. Cutouts for breaker handles to allow operation of breakers without entering compartment.
 - 5. Emergency generator receptacle: weatherproof grounding receptacle, coordinate specifications with Lewisburg Water and Sewer Department.
 - 6. Convenience outlet: duplex, 15 amp, ground fault interrupting, 15 amp, 120 volts ac, single phase, 60 hz.
- H. Mount the following, at minimum, behind dead front:
 - 1. Pump time delay relay.
 - 2. Circuit breakers.
 - 3. Motor starters and motor overload protection.
 - 4. Surge protection devices.
 - 5. Control transformers.
 - 6. Power monitor.
 - 7. Alarm circuitry.
 - 8. Remote monitoring and alarm contacts.
- I. Circuit breakers: indicating type, quick-make quick-break thermal magnetic breakers; operating handle with on-trip-off positions, with trip in middle position; inverse time characteristics through use of bimetallic tripping elements supplemented by magnetic trip for instantaneous protection; overload on one pole automatically trips and opens all legs; field installed handle ties not permitted.
 - 1. Capacity: as shown on electrical design drawings
 - 2. Provide separate circuit breakers for main power and emergency power; mechanically interlock to prevent simultaneous operation of both power sources.
 - 3. Individually protect control circuits and duplex receptacle by circuit breakers.

- 4. Motor circuit breakers: size to meet pump motor operating characteristics.
- J. Motor starters: open frame, across the line, full voltage, nema rated with individual overload protection for each phase; starter contact and coil replaceable from front of starter without removing from its mounted position.
- K. Motor overload protection: As per manufacturer's recommendations.
- L. Control transformers: fused transformers and grounded secondaries.
- M. Surge protection: provide incoming power solid state devices with led indicator lights for power and protective status.
 - 1. Line side: lightning surge arresters complying with ieee c62.11.
 - 2. Load side: transient voltage surge suppression complying with ul 1449.
 - 3. Rating: 50,000 amps per phase with response time less than 5 nanoseconds.
- N. Power monitor: line voltage rated, solid-state, adjustable, plug-in monitor to sense reversed or loss of a phase, de-energizing upon sensing any faults and automatically restoring service upon return to normal power; activate alarm indications upon loss of normal power.
- O. Alarm indicators: alarm light and horn mounted on exterior of power enclosure.
 - 1. Light: weatherproof and shatterproof red strobe alarm light fixture rated at 100,000 peak candle power, 80 flashes per minute.
 - 2. Horn: not less than 90 db at 10 feet.
 - 3. Power supply: 12 volts dc, with battery backup rated for 7 amphours, minimum.
 - 4. Battery: rechargeable, with plug-in base charger, solid state circuitry; automatically recharge after restoration of main power; full charge requiring maximum of 20 hours.
 - 5. Push-to-test button for light and horn, power-on light.
 - 6. Controls: manual alarm silence switch that deactivates horn but leaves light flashing until alarm condition ceases to exist; when alarm condition ceases to exist reset alarm function for normal operation.

7. Remote monitoring and alarm indication: provide one normally open and one normally closed unpowered contacts for remote monitoring and alarm indication, wired to terminal strip.

2.9 SOURCE QUALITY CONTROL

A. Test pump, valve, and piping assembly in factory prior to shipping, at test pressure equal to 50 percent more than pump discharge pressure or total dynamic head, whichever is greater.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify inlet and discharge piping connection match size, location, and elevation shown on drawings.

3.2 PREPARATION

- A. Establish elevations of packaged pumping station as shown on plans.
- B. Establish minimum separation as shown on plans.

3.3 INSTALLATION

- A. Install as indicated, in accordance with drawings and manufacturer's instructions.
- B. Where equipment is mounted on concrete, grout attachments before connecting piping.
- C. Set water level controls at elevations indicated.
- D. Attach final as-built drawings of components in wet well, components above ground, and controls, laminated in mylar, to inside of pump station front door; include legends and pump nameplate data.
- E. Provide to owner complete package of posted instructions, consisting of labels, signs, and operating instructions.

3.4 MANUFACTURER FIELD SERVICES

A. Provide the services of equipment manufacturer's technical representative to direct startup of station and instruct owner's personnel in startup, operation, and maintenance procedures. A start up report is to be provided to utility after start up.

3.5 FIELD QUALITY CONTROL

- A. Where components are mounted on or in concrete, wait minimum of 5 days after concrete placement before testing.
- B. After installation but before backfilling or connecting to sewer piping, test pump, valve, and piping assemblies under test pressure equal to 50 percent more than pump discharge pressure or total dynamic head, whichever is greater, using clean water.
 - 1. Simulate varying water level conditions to show that pump controls are working properly.
 - 2. Activate each control function to check for proper operation and indication.
 - 3. Include alarm conditions to show that alarms are correctly connected and functioning.

3.6 SITE WORK

- A. Access Drive: A gravel or asphalt drive of at least 12 feet in width must be provided to the pump station from the nearest public street within the development.
- B. Gravel Pad: Install filter fabric and 6" thickness crushed stone pad within fenced area and on access drive.
- C. Fencing: Install 40'x40' chain link fence of 6-feet height with three strands of barbed wire.
- D. Gate: Provide 14' wide double swing gate with three strands of barbed wire with locking mechanism.
- E. Yard Hydrant: Provide a yard hydrant within the fenced area of the pump station to provide a water source for rinsing of equipment.
- F. Electrician to coordinate route of electricity into pump station site with Lewisburg Water and Sewer Department.

3.7 ACCEPTANCE

- A. Letter: After testing and Manufacturer's Startup and receipt of the startup report, the developer shall request an Acceptance Letter from the Lewisburg Water and Sewer Department.
- B. Warranty: A 1-Year unlimited warranty shall be provided starting at the time of the Acceptance Letter from the Lewisburg Water and Sewer Department.

END OF SECTION

SECTION 333300 SEWAGE PUMP STATION SCADA SYSTEM

PART 1 GENERAL

1.1 The contractor shall furnish all labor, materials, tools, equipment, and perform all work and services necessary for or incidental to the furnishing and installation, complete, of all pump station SCADA equipment as shown on drawings and as specified in accordance with provisions of the contract documents and completely coordinated with that of all other trades.

Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, complete, and compatible installation shall be furnished and installed as part of this work.

1.2 DESCRIPTION OF SCOPE OF EQUIPMENT AND SERVICES FROM MICRO-COMM, INC.:

The contractor shall furnish a complete SCADA system that is in complete conformance with the City of Lewisburg Standards and is compatible with their existing equipment.

The Contractor shall purchase the following equipment and services from Micro-Comm, Inc. of Olathe, Kansas (represented in Tennessee by Brann and Whittemore, Inc. 615-377-9444). Equipment to include:

Micro-Comm M1650 remote unit in a wall mount JIC enclosure with "M1650 PLC" RTU module, I/O sub-panel type construction, Motorola radio transceiver, 120/12Vdc power supply, coaxial cable lightning arrestor, coaxial cable, cable connectors, and Yagi antenna.

M1650 PLC-Remote Terminal Unit (PLC-RTU) panel shall include the following: Quantity Description

- 1 Hoffman 24x20x8 SS Nema 4X panel
- 1 120 VAC/20 VAC transformer
- 1 24-hour battery back-up (12A/hr.)
- 1 M1650 PLC assembly
- 1 Motorola Radio
- 1 Motorola power & modem interface cable
- 1 Coaxial lightning arrestor, patch cord, and bracket
- 1 Micro-Comm Keypad & Display Module with cable
- 1 Engineering, programming, and testing

Four (4) control outputs as follows:

4 Spares

Eight (8) Discrete Inputs as follows:

- 1 High Wet-well Alarm
- 2 Pump 1&2 Running (interface with Pump Control Panel)
- 2 Pumps 1-2 Failure Alarms (interface with Pump Control Panel)
- 1 Power Failure/Phase Failure (interface with Pump Control Panel)
- 2 Spares

Four (4) analog inputs, used as follows:

4 Spare analog inputs

The following items are to be shipped separately for field mounting by the Contractor:

- 1 Yagi antennal with mounting U-bolts
- 1 Lot of coaxial cable and connectors as needed

SCADA System Software Modifications: The CTU panel modifications to include:

- 1 SCADA CTU-PLC Program/Network Modifications
- 1 SCADA CTU Software Program Modifications (SCADAview CSX)

Miscellaneous items included in Micro-Comm Scope of Supply:

- 1 Engineering and design services Engineering submittal
- 1 Operation and Maintenance Manuals per specifications
- 1 Path study to determine required antenna height and direction.

<u>Note:</u> Contractor shall also purchase and install antenna pole, and mount antenna with cable provided by Micro-Comm.

- 1 FCC License Fees and Paperwork
- 1 Freight to Job site (FOB Factory,
- 1 Freight allowed) Factory startup and adjustment service.
- 1 Five-year parts and labor warranty (New RTU only)

The Contractor shall include in his bid the cost of the above scope of

services.

1.3 DESCRIPTION OF SCOPE OF EQUIPMENT AND SERVICES BY CONTRACTOR

Contractor shall furnish and install all field wiring from the RTU to the SCADA termination cabinet, and from the cabinet to the various panels, transmitters, and equipment as required to provide the discrete and analog inputs listed herein. The Contractor shall make all wiring terminations, except for the terminations in the RTU of the wiring from the SCADA cabinet to the RTU. The Town personnel shall make those final terminations. The Contractor shall maintain a detailed drawing and wire numbering system, coordinated with the drawings provided by Micro-Comm, to correctly identify each field wire extended into the RTU; this drawing shall be turned over to the Town staff to assist them with the final terminations in the RTU. The Contractor shall furnish and install the antenna pole as required by the path study.

For the purposes of bidding this project, <u>the Contractor shall</u> <u>assume an antenna</u> <u>height of 30 feet above ground</u>. The contract price will be adjusted, based on material costs, if the path study indicates a different antenna height is required. The Contractor shall make final connections, prepare record drawings, and coordinate start-up and demonstration of SCADA system completion.

1.4 SHOP DRAWINGS:

Submit the following shop drawings for approval:

- 1. Electrical schematic control diagrams, which shall include:
 - a. Terminal identification
 - b. Unique identification of all control devices and contacts
 - c. Wire identification
 - d. Equipment identification
 - e. Indication of remote and local devices and wiring
 - f. System voltage and overcurrent protection indication
 - g. All control logic
- 2. Panel fabrication drawings
- 3. Nameplate layout drawings

1.5 SCADA SYSTEM START-UP AND TEST:

The SCADA system shall be checked by the equipment suppliers and vendors for proper operation, prior to start-up and testing. System shall be determined to be fully operational, and all defects corrected, prior to start-up testing by the Engineer. System shall be tested, and all inputs and alarm conditions shall be simulated under the Engineer's supervision and direction. Testing activities shall include the simulation of both normal and abnormal operating conditions. A written report shall be provided by the start-up personnel.

1.6 O&M MANUALS:

O&M Manuals shall be provided for the SCADA system components. Each manual shall include complete parts lists, troubleshooting procedures, maintenance schedules, as-built wiring diagrams, and all other information necessary to maintain the specific equipment item in proper working order.

Furnish three copies of the O&M manuals, each bound in a combed binder and one electronic (PDF) file.



- 6. Run 1" conduit to existing vault. You may need to provide 3/4" hub connection if vault is not equipped. Install transducers/sensors in pit and connect.
- 7. Pressure taps will be provided by others unless specified otherwise.
- 8. Run flow rate signal wire in the 1" conduit shown above and connect to existing meter head transmitter.
- 9. Run miscellaneous 120VAC signal wires in above 1" conduit.
- 10. The maximum horizontal conduit run is 30ft.
- 11. NO CONDUIT CONNECTIONS SHALL BE MADE IN THE TOP OF THE ENCLOSURE.

Typical Mounting of Outdoor RTU

General

All remote panel boxes should be mounted securely to eliminate excessive vibration. Outdoor installation can be done by mounting the rainproof enclosure to (2) four-inch by four inch treated posts or corrosion resistant supports using mounting-strut channel and brackets as shown. The remote unit should be located as close as possible to the water tower ladder or pole where the antenna is mounted. All ³/4" or 1" rigid power and transducer conduit connections to the enclosure shall be located in the lower right hand corner of the panel, and antenna coax conduit connections shall be located in the lower left hand corner of the panel. This will insure space is available for the RTU battery. All wires in and out of the RTU must be in ³/₄" or 1" rigid conduit. The only exception will be the ground wire as shown. The ground wire can exit the box via a drilled hole in the rear left corner of the panel. Typical conduit runs will be to electrical service, meter pit or vault for the transducer, and the antenna. The antenna conduit vertical run must be at least 15 feet up to a weatherhead. NO CONDUIT CONNECTIONS SHALL BE MADE IN THE TOP OF THE ENCLOSURE. Grounding for the RTU is accomplished by driving an 8/10-ft copper clad ground rod as close to the remote as possible. Using #8 or #10 solid copper wire, attach the ground rod to the coax lightning arrestor on the interior panel as depicted below. Any holes in the exterior enclosure MUST be sealed with silicone to keep the insects out.





Typical Mounting of Indoor RTU

RTU in Building with Antenna on Pole **NOTE : THE MAXIMUM DISTANCE FROM** THE MICRO-COMM RTU TO THE ANTENNA DRIP LOOP 1-1/2" X 10' STRUCTURE IS 20'. MINIMUM CONDUIT MAST ANTENNA HEIGHT =20FT 5/8" X 6" LAG BOLTS DRIP LO MICRO-COMM WEATHERHEAD RTU **1" NIPPLE** THROUGH WALL 3/4" RIGID 1-1/2" LB CONQUIT. CONNECTOR 3/4" RIGID CONDUIT. COA #8 OR #10 GROUND WIRE 8/10 FT DEDICAT :D GROUND ROD

- 1. Mount RTU on wall in building at eye level.
- 2. Run 3/4" conduit to existing AC power.
- 3. Provide 8'/10' ground rod at location outside near RTU and wire to antenna coax lightning arrestor with 8 gauge copper wire.
- 4. Run 1"+ conduit to existing power pole with weatherhead for coaxial cable.
- 5. Install antenna on pole with 10ft mast, run coax to RTU enclosure.
- 6. Run 1" conduit to motor controls for control wires. This conduit may also be used for incoming AC power.
- 7. Flow monitoring signals, pressure transducer signals or any other DC signals require separate conduit separated from AC signals.
- 8. Run miscellaneous 120VAC signal wires in above 1" conduit.
- 9. NO CONDUIT CONNECTIONS SHALL BE MADE IN THE TOP OF THE ENCLOSURE.

Antenna Installation

General

The antenna is a very critical link in radio telemetry. Correct installation is a MUST for proper radio communications. The installer/contractor of the equipment must follow the requirements set by Micro-Comm. If these requirements are not met, then the Installer/Contractor must redo the installation at their expense.

The minimum antenna height shall be fifty feet (50 ft), for standpipes, ground storage, and elevated tanks. Central terminal units located at plants and offices, shall have a minimum height of forty-five feet (45 ft). All other remotes shall have a minimum antenna height of twenty feet (20 ft). Use these heights unless otherwise specified. Micro-Comm supplies mounting brackets, U-bolts, coax, connectors, and tape for proper installation. Attaching the coax connector is very critical, requiring the installer to contact Micro-Comm for proper connection instructions. A typical procedure that works well at Micro-Comm is for the installer to complete the remote installation, with the exception of the antenna and coax. During start-up of the remote, Micro-Comm will attach the coax to the antenna (including proper taping), then allow the installer to finish mounting the antenna. The installer may make antenna connections if previous arrangements have been made with Micro-Comm. Antenna polarization (vertical or horizontal) will be specified on a job-by-job basis (if it is not specifically stated, use horizontal polarization). Specific information on installation is covered on pages

19, 20,21 of this manual.



Side View of Antenna

NOTE: The antenna connector shall have six layers of electrical tape covering the coax connector. All other points have six layers of electrical tape (all tape is provided by Micro-Comm). Coax should be taped every 3' to the mounting structure.

Typical Pump Station RTU Connections



Attachment 1

Standard Details





















