GRAND STRAND
WATER & SEWER
AUTHORITY

SEWER SYSTEM STANDARDS

AND

SPECIFICATIONS

PREPARED BY:

PLANNING/ENGINEERING DIVISION

GRAND STRAND WATER AND SEWER AUTHORITY

PO BOX 2368

166 JACKSON BLUFF ROAD (29526)

CONWAY SC 29528-2368

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SEWER SPECIFICATIONS

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CHAPTER 1

DEFINITIONS, ABBREVIATIONS, AND GENERAL

1.1 INTERPRETATION OF CERTAIN TERMS OR WORDS

Except as specifically defined herein, all words used in these standards have their customary dictionary definitions. For the purposes of this policy, certain words or terms used herein are defined as follows:

1.1.1 Words used in the present tense include the future tense. Words used in the singular include the plural and words used in the plural include the singular.

1.1.2 The word "shall" is always mandatory.

1.1.3 The word "may" is permissive.

1.1.4 The word "lot" includes the word "plat" or "parcel".

1.1.5 The word "person" includes a firm, association, organization, partnership, trust company, or corporation as well as an individual.

1.2. DEFINITIONS

1.2.1 Authority

The Board of Directors of the Grand Strand Water and Sewer Authority is the governing Authority.

1.2.2 DHEC

Department of Health and Environmental Control of the State of South Carolina.

1.2.3 Lot

A part of a subdivision, or parcel of land used as a building site or intended for such use, immediate or future.

1.2.4 Utility Easement

Private easements for Authority utilities shall be dedicated to the Authority for installation of utility piping and appurtenances. Utility easements shall be obtained from the property

owner by execution of a probated easement agreement and recorded in the Register of Mesne Conveyance.

1.2.5 Public Right-of-Way/Easement

Public right-of-ways or easements are considered to mean street right-of-ways or any other public right-of-ways.

1.2.6 Engineer

A person registered as a Professional Engineer in good standing with the South Carolina Board of Engineering Examiners.

1.2.7 Land Surveyor

A person registered as a Land Surveyor by the South Carolina Board of Engineering Examiners.

1.2.8 Subdivision

The division of a tract of land into two or more lots for the purpose, whether immediate or future, of sale, legacy, or development. This includes all division of land involving a new street or a change in the arrangement of streets and includes any re-subdivision of land. Subdivision shall also refer to uses of land not ordinarily considered a subdivision but requiring utility installations. Examples of these non-subdivision uses are mobile home parks, multifamily projects, townhouses, and planned unit developments.

1.2.9 Developer

Any person, firm, corporation, or other legal entity improving property for commercial, industrial, or residential purposes.

1.2.10 Plat

A map or drawing upon which the development plan is presented for approval.

1.2.11 Contractor

A person or entity authorized to perform construction by the State of South Carolina Licensing Board for Contractors. A contractor may not perform work outside of his licensed capacity. This includes well drillers, water and sewer lines, pump station, and electrical contractors. Where required, all sub-contractors must be certified. The Authority reserves the right to accept or reject any contractor or sub-contractor selected to perform work on the systems to be conveyed to the Authority.

1.2.12 Design

The design of sewer systems shall be done only by persons properly registered under the Professional Engineer's Act of the Business and Professions Code of South Carolina.

All calculations requested by the Authority to verify the design of any portion of the sewer system shall be submitted to the Authority for their use. Calculations shall be based on rational methods generally accepted by the engineering profession and shall be neatly and legibly done in such form as to enable them to be readily checked.

1.2.13 Standard Drawings

Standard drawings, the latest revisions thereof, approved by the Authority for sewer system construction purposes shall be considered a part of these standards and shall be used in conjunction with these Standards for all subdivision and extension of sewer system installations. Construction by methods differing from the Standard Drawings which will give equivalent or better results may be approved by the Authority if prior approval or such methods is obtained.

1.2.14 Conflicts

In case of conflict between contract documents, plans, wastewater specifications, or Standard Drawings, precedence shall be given in the following order:

(1) Contract Documents, (2) Standard Drawings, (3) These Wastewater Specifications, and (4) Plans. However, a deviation from the Standard Drawings or these Wastewater Specifications will be approved if a specific note regarding the particular deviation is included on the Plans and Specifications.

1.2.15 Customer

Customer means any person, firm, association, or governmental agency supplied or entitled to be supplied with sewer service.

1.2.16 Other Specifications

Whenever in these Standards other specifications are mentioned, it shall be understood that the materials or methods mentioned shall conform to all requirements of the latest revision of the specifications so mentioned.

1.2.17 Paved Surface

Paved surface includes any pavement used on any street in the county, whether such pavement is composed of concrete, asphalt, oil, gravel, crushed rock or any combination of said forms of pavement.

1.2.18 P.S.I.G.

P.S.I.G. means pounds per square inch, gauge.

1.2.19 Plans

Plans means all plans, profiles, maps or drawings which show the location, character, dimensions, and details of the work which has been approved for construction by the Engineer.

1.2.20 Service Lateral

Service lateral means a connection between a sewer main and user house service sewer lateral.

1.2.21 Pump Station

Pump Station means a structure and/or pumping facility to facilitate the further transmission of waste water through the use of pumps and periodic minimal storage (wet well).

1.2.22 These Standards

These Standards shall mean those specifications approved by the Engineer for work covered by these Specifications.

1.2.23 User Connection

User connection means the point of connection of a user's piping to the Authority's sewer service lateral.

1.2.24 Sewer Main

Sewer main means any pipe or conduit that is part of a collection system and is used to collect or is intended to be able to collect sewer flow from more than one user connection.

1.2.25 Sewer System

Sewer system means the source, facilities, collection and transmission system and shall include all those facilities of the sewer system under the control of the Authority up to the customer's connection.

1.2.26 Use of Sewer

Connection of house services to service laterals and subsequent use of sewer either temporarily or permanently, shall not be allowed prior to operational approval of the sewer system by the Authority.

1.3 ABBREVIATIONS

Whenever in these standards the following abbreviations are used, the intent and meaning shall be interpreted as follows:

AA	Aluminum Association
AAMA	Architectural Aluminum Manufacturer's Association
AASHTO	American Association of St. Highway and Transportation Off.
ACI	American Concrete Institute
AFBMA	Anti-Friction Bearing manufacturers' Association
AGA	American Gas Association
AGMA	American Gear manufacturers' Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
APA	American Plywood Association
API	American Petroleum Institute
AREA	American Railway Engineering Association
ASAE	American Society of Agriculture Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
ASTE	American Society of Transportation Engineers

ASTM	American Society of Testing and Materials
AWI	American Welding Society
AWPA	American Wood Preservers' Association
AWPB	American Wood Preservers Bureau
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers' Association
CBMA	Certified Ballast Manufacturers' Association
CDA	Copper Development Association
CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers' Association of America
CRSI	Concrete Reinforcing Steel Institute
FED SPEC.	Federal Specifications
HI	Hydraulic Institute
HMI	Hoist Manufacturers' Institute
ICBO	International Conference of Building Officials
IEEE	Institute of Electrical and Electronics Engineers
ICEA	Insulated Cable Engineers' Association
JIC	Joint Industry Conferences of Hydraulic Manufacturers'
MMA	Monorail Manufacturers' Association
NBHA	National Builders' Hardware Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NLMA	National Lumber Manufacturers' Association
NWMA	National Woodwork Manufacturers' Association
OECI	Overhead Electrical Crane Institute
OSHA	Occupational Safety and Health Act (Both Federal & State)
PS	Product Standards Section - US Dept. of Commerce
RLM	RLM Standards Institute, Inc.
RMA	Rubber Manufacturers' Association

SAE	Society of Automotive Engineers
SDI	Steel door Institute
SSPC	Steel Structures Painting Council
TEMA	Tubular Exchanger Manufacturers' Association
TCA	Title Council of America
UBC	Uniform Building Code
UL	Underwriters' Laboratories, Inc.
WWPA	Western Wood Products Association
SCDOT	SC Department of Transportation

Unless a particular issue is designated, all references to the above specifications, standards, or methods shall, in each instance, be understood to refer to the issue in effect (including all amendments).

1.4 GENERAL CONTRACTOR REQUIREMENTS

1.4.1 Coordination

Contractors shall cooperate in the coordination of their separate activities in a manner that will provide the least interference with operations of the Owner, or Authority and other contractors or utility companies working in the area. If any difficulty or dispute should arise in the accomplishment of the above, the problem shall be brought immediately to the attention of the Engineer.

All Contractors working on site are subject to this requirement for cooperation and all shall abide by the Engineer's and/or Authority's decision in resolving project coordination problems without additional cost to the Engineer, Owner or Authority.

1.4.2 Shutdown of Existing Operations or Utilities

Continuous operation of the Authority's existing services or utilities, or for other work that requires the temporary shutdown of any existing operations or utilities shall be planned in detail with appropriate scheduling of the work and coordinated with the Engineer and the Authority.

All materials and equipment (including emergency equipment) necessary to expedite a tie-in shall be on hand prior to the shutdown of existing services or utilities.

1.4.3 Operation of Existing System

At no time is it allowed to close off any sewer lines or take any other action which would affect the operation of the existing system, except as specifically required by the Drawing and specifications and after prior approval has been granted by the Authority. Request approval a minimum of 5 working days in advance of the time that interruption of the existing system is required.

1.4.4 Scheduling

Plan the work and carry it out with minimum interference to the operation of the existing facilities. Prior to starting the work, confer with the Engineer and the Authority's representative to develop an approved work schedule which will permit the facilities to function as normal as practical. A pre-construction conference shall be conducted per Authority Extension Policy in effect. It may be necessary to do certain parts of the construction work outside normal working hours in order to avoid undesirable conditions. The Contractor shall do this work at such times and at not additional cost to the Authority or Owner. Do not make connections between existing facilities and new work until necessary inspection and test have been completed on the new work and it is found to conform in all respects to the requirements.

Work on existing structures and facilities shall be performed on a schedule and in a manner that will permit the existing facility to operate continuously.

1.4.5 Equipment Maintenance During Construction

All equipment installed shall be provided by the contractor with the manufacturers' recommended oil and lubricants and shall be maintained and operated by the Contractor until final acceptance by the Owner or Authority. However, approval to operate specific equipment on a temporary basis until final acceptance is achieved may be obtained from the Authority. Said special circumstances and equipment must be substantially complete and written request and approval by the Engineer of work must be submitted for the Authority's review and approval or denial.

1.4.6 Equipment and System Testing

Functional (or run) testing, in the presence of the manufacturers' representative and/or Engineer, will be required for each item of equipment following installation. Functional testing is defined as that testing necessary to determine if installed equipment and system will operate as intended.

In addition to the functional test, specific performance testing of installed equipment and systems shall be conducted by the Contractor as required in the section specifying the equipment or system. The Contractor shall furnish all labor, materials, tools, equipment, instrument, and services necessary to perform the functional and performance testing.

1.4.7 Progress of Pipeline Construction

The work shall proceed in a systematic manner so that a minimum of inconvenience will result to the public in the course of construction. It is, therefore, necessary to confine operations to as small a length of work area per crew as is practical. Normally, the trenching equipment shall not be farther than 200 feet ahead of each pipe-laying crew or such distance as necessary to provide maximum safety. Backfill the trench so no section of approved pipe is left open longer than is absolutely necessary.

1.4.8 Safety

The Contractor will be completely responsible for the safety conditions of the job site including compliance with all applicable laws. Safety conditions will include, but is not limited to, pipe construction, trenching, chemicals, electrical, blasting and other construction procedures or items utilized for the project.

1.4.9 Shop Drawings and Submittals.

The Contractor will provide the Authority with six (6) sets of shop drawings for all applicable items.

1.5 CONSTRUCTION PERMITS GENERAL REQUIREMENTS

1.5.1 General Requirements

1) Facilities needing a construction permit include: Main Sewers, Wastewater Collection and Transmission Systems, Pump Stations and Force Mains, Wastewater Treatment Facilities, and Components. Activities not requiring a construction permit include replacement of a component (same or similar), as long as there is no change in capacity, routine maintenance, and the construction of buildings. However, for all other modifications, including relocation of sewers and revisions to existing construction permits, the Authority shall be contacted for a decision on whether or not a construction permit is required.

2) Service connections which shall contribute more than five (5) percent of the existing wastewater treatment facility's design capacity, or fifty thousand (50,000) gpd, shall be approved by the Authority. This approval is for the additional flow and not for the physical work or materials.

3) Individual service connections as defined in the regulation may require GSWSA approval prior to connecting to a sewer system if the wastewater treatment facility receiving the flow from the individual service connection is under a tap moratorium imposed by the SCDHEC.

4) Double residential service connections are not considered main sewers and shall, therefore, not require a construction permit from the Authority. However, the common line shall be owned, operated and maintained by the same entity that owns the main sewer system that the common line is tying onto. Other double service connections shall be reviewed by the Authority on a case-by-case basis, to determine if a construction permit is required and to confirm ownership requirements are met.

5) Individual pressure connections to force mains are considered collectors and shall require that a construction permit be issued by SCDHEC, unless the entity owning the sewer system is a Delegated Review Program entity with an approved Alternative Sewer Management Plan.

6) When the proposed system is located off the applicants property, easements or documentation of recorded easements, excluding encroachment permits and navigable waters easements, are required to be submitted to the Authority prior to permitting for all applicants.

7) No construction permit shall be issued for a wastewater treatment facility, including effluent disposal lines, unless the applicable effluent disposal permit has been issued and has not been appealed (or either the period to appeal has lapsed without appeal, or the appeal has been resolved to sustain the permit). In cases where the effluent disposal permit has been issued, but has been appealed according to applicable laws and regulations, the effluent disposal permit shall be considered not to have been issued for the purposes of determining whether a construction permit may be issued for proposed wastewater treatment facilities.

8) Proposed sewer systems shall connect to existing systems with available capacity or to another proposed sewer system, with available capacity (including considerations of infiltration and inflow), which has already received a construction permit from the SCDHEC. Where a construction permit has been issued on the downstream components though not yet operational, a construction permit on the proposed sewer system may be issued, but the approval to place in operation shall not be issued until all downstream components have received an approval to place in operation.

    a. Downstream Sewer Systems. Construction permits shall not be issued in cases where adequate capacity in the downstream components of the wastewater facilities is not available to handle the design flow of the proposed project. Adequate capacity for

sewer lines and pump stations means that the existing sewer facilities, including the wastewater treatment facility receiving the wastewater, have the capacity as currently permitted. An evaluation of available capacity may be made based on factors such as flow projections from previously permitted projects (including considerations of infiltration and inflow).

b. Downstream Treatment Systems. For public and private entities, available capacity in wastewater treatment facilities may be based on its effluent disposal permit capacity (i.e., capacity may be advanced where the effluent disposal capacity is greater than the actual facility capacity to treat and dispose of wastewater). This advancing of capacity is acceptable unless actual flows exceed the permit flow limits of the existing wastewater treatment facility or the facility has violated other limits that have led to DHEC's issuance of an order to remedy the problems (and the problem has not been corrected). For facilities seeking to have capacity advanced, DHEC may require an agreement with the permittee to detail the conditions of advancing capacity. The permitted flow at a wastewater treatment facility may be adjusted based on a review of Discharge Monitoring Reports data or other data collected by independent sources to address issues such as infiltration and inflow.

c. Exceptions. A construction permit may be issued for a sewer system and/or pretreatment system where the downstream components have yet to be issued a construction permit, or do not presently have adequate capacity if:

1. a preliminary engineering report has been submitted to and approved by DHEC for the upgrade of the downstream facilities. The preliminary engineering report shall include target dates for submitting plans, starting construction and completing construction for the necessary upgrade to the downstream facilities;
2. for a private entity, excluding industrial facilities, financial assurance (e.g., an escrow account), which includes adequate funds to complete the upgrade of the downstream facilities, has been established; and
3. the increase to the effluent disposal permit has been issued and has not been appealed (or either the period to appeal has lapsed without appeal, or the appeal has been resolved to sustain the permit) for the wastewater treatment facility so that there is adequate permit capacity available for the proposed sewer system.

9) Prior to the issuance of a construction permit for a collection system, including pump stations and force mains, to serve more than one (1) parcel of deeded property (e.g., subdivisions, condominiums), with the exception of industrial facilities, the project owner shall provide DHEC with documentation that the collection system, including the pump stations and force mains, shall be owned, operated and maintained by a public entity. An exception can be made where there are several platted properties with a common owner in an area (e.g., hospital complex) where there is not a reasonable expectation that the

project area would later serve different owners. Proposals by private entities shall be evaluated on a case-by-case basis. SCDHEC may evaluate the capability of reliable system operation in its evaluation.

10) All sewers shall be constructed with a minimum of three (3) feet of cover, unless justified by the applicant and approved by GSWSA (e.g., use of ductile iron pipe may have cover less than three (3) feet).

11) Sewer lines, manholes, pump stations, force mains, and wastewater treatment facilities shall be located more than one hundred (100) feet from a public water supply well. Sewer lines, manholes, pump stations, and force mains shall be located at least twenty (20) feet from any other potable well, as defined in Regulation 61-71. Wastewater treatment facilities shall be located at least one hundred (100) feet from any other potable well, as defined in Regulation 61-71. Special designs may be considered which shall provide equivalent protection to the well when this requirement is not achievable.

12) If a proposed wastewater system requires construction in State navigable waters and the Authority determines that a permit shall be issued for the construction in navigable waters, considerations of the navigable waters permit process may be incorporated into the review for the wastewater construction permit.

13) Proposed wastewater systems require a Coastal Zone consistency review by DHEC's Office of Ocean and Coastal Resource Management (OCRM) as part of the wastewater construction permit process, unless a general certification applicable to the project from OCRM has already been provided.

CHAPTER 2

SEWER SYSTEM INSTALLATIONS

2.1 GENERAL

The Contractor shall perform all work necessary for or incidental to the performance and completion of sewer system installations. This work shall be completed as shown on the latest revisions of the standard drawings and as may be specified in contract documents. This work shall include the furnishing of all labor, materials and equipment necessary for a complete and operational system. The contractor shall be responsible for coordinating the work to assure that the work is completed in an orderly manner.

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

2.1.1 Existing Utilities, Structures, and Other Items

The contractor will take precautions to prevent any unnecessary damage to existing utilities, structures, property and other items in the work area. Any work resulting in damage to utilities, structures or other items as a direct or indirect result of the Contractor's work shall be the responsibility of the Contractor. Any liabilities, fines or penalties to the Authority resulting from damage caused by the Contractor or from negligence of the contractor shall be reimbursed by the contractor.

The contractor will be responsible for verifying the location and existence of all underground utilities. Location of utilities on the plans, whether fully and correctly located or partially and/or incorrectly located or omitted will not relieve the Contractor of the responsibility or liability for damage to the utilities. The Contractor will be responsible for contacting local utilities for assistance in locating utilities. The Contractor must fully comply with the South Carolina Underground Utilities Damage Prevention Act, General Statutes 58-35 Sections 20 through 120 and all applicable statutes and state approved requirements.

The Contractor shall replace and/or repair any drainage culverts necessary to be removed or that have been damaged during work performed. All drainage from ditches or culverts shall be maintained during progression of the work so that any damage to the property, public or private will not result from lack of or diversion of existing drainage courses. At completion of the project, all drainage ditches and culverts will be completely opened and natural drainage restored. It will be the responsibility of the Contractor to replace property corners to proper locations if damaged or destroyed as a result of the Contractor's work.

The Contractor shall be responsible for obtaining a letter of release from SCDOT for work performed in State right-of-ways or from Horry County Public Works for work performed

within county right-of-ways. Final release of retainage shall not occur until all letters of release are provided to the Engineer.

2.1.2 Debris Removal

All material and debris resulting from clearing operations shall be disposed of by the Contractor as directed by the Engineer and/or the Authority.

2.1.3 Unclassified Excavation

All excavated material removed for sewer system installations shall be considered unclassified material.

2.1.4 Excess Materials

All excess materials will be disposed of by the Contractor at a location or in a manner approved by the Engineer and/or the Authority.

2.1.5 Access

The Contractor during the course of the work will maintain a full access to public or private properties including but not limited to driveways, sidewalks, fire hydrants and streets. The Contractor is responsible for coordinating work to minimize any inconvenience to the public as a result of the construction work under this contract. The length of trench open per crew at any one time will not exceed 200 linear feet unless otherwise approved by the Engineer and no section of trench will be left open any longer than is absolutely necessary. Failure to comply with these provisions may necessitate shutdown of the entire project until back filling of open trenches is performed. The Contractor will be responsible for the safety conditions of the open trench.

2.2 PIPELINE TRENCHING

2.2.1 Trenching, General

a. Trenches will be excavated by the open cut method to a depth shown on the plans and necessary to accommodate the work including bedding. The Contractor shall take precaution to avoid excavating below the necessary depth in order to maintain existing firm conditions. In the event of over excavation, the trench will be back filled with approved materials and thoroughly compacted in six (6) inch lifts.

b. Trench widths will be limited to provide ample room for workmen. Trench widths at the top of the pipe will not exceed the total width of the outside diameter of the pipe plus eighteen (18) inches for pipes with outside diameters of thirty-three (33) inches and less,

and the total width of the outside diameter of the pipe plus twenty-four (24) inches for pipes with outside diameters greater than thirty-three (33) inches. When sheeting is necessary the allowable trench width will be increased by the thickness of the sheeting.

c. Trench walls shall be cut vertically from the trench bottom to the top of the pipe. Top of trench width shall not exceed a width brought about by a one and one-half (1-1/2) horizontal to one (1) vertical slope from the top of the pipe to the surface of the ground. The maximum allowable top of trench width will be fifteen (15) feet unless otherwise approved by the Engineer. Any damage to any item, including pavement, as a result of exceeding the allowable trench width, and any liability thereof, will be considered the responsibility of the Contractor.

2.2.2 Trenching Methods

a. Trench excavation shall be made in open cut and true to the lines and grades shown on the plans, unless boring is necessary or required. Banks of the trenches shall be cut in vertical, parallel planes equi-distant from the pipe center line. The horizontal distance between such planes, or the overall width m of trench shall be as recommended by manufacturer. When trench excavation is not practical to construct or create dangerous conditions to workmen due to the 15' maximum trench width limit, the Engineer may direct the contractor to exceed the 15' limit, provided that such excavation does not damage adjacent structures. When trench banks are sloped, such banks shall be cut to vertical planes as specified above for the part of the ditch below the level of 12 inches above the top of the pipeline. The bottom of the trench shall be level in cross section and shall be cut true to the required grade of the pipe and the pipe embediment materials. All trenching shall conform with OSHA regulations.

b. Bell holes for bell-and-spigot pipe shall be excavated at proper intervals so that the barrel of the pipe will rest for its entire length upon the appropriate bedding material. Bell holes shall be large enough to permit proper joint installation in the pipe.

c. When muck, quicksand, soft clay, swampy or other material unsuitable for foundations or sub-grade are encountered such material shall be removed and replaced with approved pipe foundation bedding material consisting of gravel or crushed stone of a maximum diameter of ¾".

   After excavation the space below the ultimate pipe grade shall be filled with pipe embediment materials consisting of gravel or crushed stone of maximum diameter of ¾". Embediment shall be a minimum thickness of 4" below piping and up to the springboard of pipe (centerline). Embediment shall extend the full width of trench and be compacted to proper grade and made ready for pipe laying.

d. Debris encountered in trench excavation for sewer and other pipelines shall be removed for the overall width of trench which shall be as shown on the plans. It shall be removed to a depth of six (6) inches below the bottom of the pipe for pipes smaller than twenty-four (24) inches in size; eight (8) inches below the bottom of the pipe for pipes twenty-four (24) inches to thirty-six (36) inches in size and twelve (12) inches below the bottom of the pipe for pipes larger than thirty-six (36) inches in size, if debris extends to such depth.

e. Bracing and sheeting will be provided as necessary to comply with trench width requirements of OSHA and other federal, state, and local requirements. The use of drag boxes or similar items may be acceptable provided subsequent moving of the box does not result in cave-ins. Sheeting shall be left in place until the pipe has been placed and back filled in the area of the pipe. Shoring and sheeting if removed must be done in a manner that will not upset pipe construction including creating unacceptable voids in the backfill.

f. The Contractor must take precautions in controlling the width of the trench to prevent unnecessary damage to adjacent roads, utilities and structures and to protect workmen and the public. The contractor will be responsible for repairs or compensation due to such damage without additional compensation from the Owner.

g. Trenches shall be kept free of water during installation of the pipes. Water shall be disposed of in a manner so as not to damage adjoining private or public properties or in a manner as to be a detriment to public health. Payment for de-watering will be included in the unit price item for the pipe lain.

h. Pipes shall be kept free from any water, trench material or debris from entering the pipe during the pipe laying operation. Pipes shall be plugged at all times to prevent foreign material and contaminated water from entering the pipe when the Contractor's personnel are not in attendance.

2.2.3 Site Grading, Back filling, and Compacting

a. The Contractor will stake out and establish proposed elevations of all items including structures, sidewalks, parking areas and utilities and any other layout work necessary for construction of the project. Grading work will be completed in accordance with the plans. Grading operations will be performed only under acceptable weather conditions and soil moisture contents. Final grades of proposed disturbed areas will be brought to existing easements, pavement, curb, grassed, water, or other area grades in a manner acceptable to the Engineer's representative even if minor adjustments from plan grades are required.

b. During grading operations, the Contractor will be responsible for maintaining proper drainage and minimizing erosion. The Contractor will be responsible for re-establishing grades due to washout, settlement or other manner prior to acceptance.

c. The Contractor shall use only suitable backfill materials which shall be free from any deleterious materials and as approved by the Engineer and/or the Authority. Backfill will be hand or pnuematic tamped under and around the pipe in six (6) inch lifts up to twenty-four (24) inches above the top of the pipe. Backfill to the top of ground will be in eight (8) inch loose thickness lifts compacted as specified. Any pipe displaced or broken during back filling or compaction will be replaced at the Contractor's expense.

d. Compaction will be to a density of 95 percent of maximum dry density as determined by ASTM-D 698 or AASHTO Method T 99 for paved, concrete, parking or other unpaved areas common to traffic. In other areas of Department of Highways and Public Transportation right-of-ways, the backfill must be compacted to ninety-five (95) percent of maximum dry density or to a density equal to that prior to the area's disturbances whichever is less. For all other areas, trench backfill will be compacted to a minimum ninety (90) percent of maximum dry density as determined by ASTM - D 698 and AASHTO Method T 99. Maximum dry density will be as determined by the Standard Proctor test.

e. When required by the Engineer, or the Authority, moisture density tests will be performed through a recognized testing laboratory. Should the compacted backfill fail the moisture density tests, the Contractor will uncover backfill until additional tests show adequate density exists. Additional tests at a site of initially failed testing will be paid for by the Contractor. Additional back filling and compaction requirements and bedding requirements are discussed in sections on Pressure Piping and Gravity Piping and are shown on the Standard trench detail drawings.

f. Said work as above described shall be considered as a part of the unit cost items and unless otherwise described no additional compensation will be allowed.

2.3 CONSTRUCTION IN PUBLIC RIGHT-OF-WAY AND EASEMENTS

2.3.1 General

The Contractor shall perform all work necessary for or incidental to the performance and the completion of construction in all public right-of-ways and easements including but not limited to furnishing all labor, materials, and equipment. this work shall be completed as shown on the drawings and as specified in the contract documents. The Contractor shall be responsible for coordinating the work to assure that the work is completed in a timely and orderly manner.

Attention is directed to the plans for the removal and/or replacement of existing landscaping, shrubs, plantings, miscellaneous storage buildings, fences and lawn areas that might be in conflict with the work or may have been damaged. The Contractor shall replace any and all damaged or removed items with equivalent materials and conditions all to the satisfaction of the property owner and GSWSA.

Although such work may not be specifically shown or specified, all supplementary or miscellaneous items removed and replaced items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation shall be furnished and installed as part of this work. Said work as above described shall be considered as a part of the unit cost items and unless otherwise described no additional compensation will be allowed.

The Contractor shall be responsible for complying with the current South Carolina Department of Health and Environmental Control, Office of Ocean and Coastal Resource Management (OCRM) regulations and requirements.

The Contractor shall perform all work necessary for or incidental to the performance and the completion of construction in all public right-of-ways and easements including furnishing all labor, materials, and equipment. This work shall be completed as shown on the drawings and as specified in the contract documents. The Contractor shall be responsible for coordinating the work to assure that the work is completed in an orderly manner.

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

2.3.2 Encroachment Permits

The Contractor will not proceed with construction within any South Carolina Department of Transportation (SCDOT) or other local county or municipal right-of-way or easement without approved encroachment permits from the appropriate agency having jurisdiction. The Contractor will keep a copy of approved encroachment permits at the project site at all times during the construction. The Contractors will be responsible for notifying and obtaining through the Engineer necessary encroachment permits from the appropriate agency, SCDOT, the county or municipality prior to initiating construction on any public right-of-way or easement. All work performed in SCDOT right-of-way will be in full accordance with the approved encroachment permits including any "Special Provisions" and SCDOT's "A Policy for Accommodating Utilities on Hwy. Right-of-ways", latest revision and these specifications. Contractor shall be responsible for obtaining a letter of release from the appropriate agency stating their acceptance of reconstruction subject to normal warranty periods.

Mail Boxes:

Where mail boxes are encountered during the installation of lines, the mail boxes and posts may be carefully removed temporarily only and shall be replaced immediately after back filling and pipe laying has passed the box location. Said box shall be replaced for use the same day as removed and shall be restored as may be needed to conform to its prior condition with the exception that the distance from the bottom of the box to ground level shall be 43". Any and all necessary replacements of posts and/or boxes needed to conform to this requirement

are considered as a part of the overall cost for pipe installation work and no additional compensation will apply.

2.3.3 Materials

All materials used within SCDOT right-of-ways will be SCDOT approved and are to be in accordance with SCDOT Standard Specifications for Highway Construction, latest edition. Base course material will be select aggregate base course (SABC) material from approved aggregate pits. Asphaltic concrete will be mix Type 3 (within the range of 6.0 and 6.5 percent liquid asphalt content) and will be mixed in approved batch plant. Asphaltic concrete will weigh a minimum of one hundred and ten (110) pounds per square yard per inch depth of asphalt placed.

2.3.4 Pavement Cut and Patch

a. Any pavement cut or damaged during course of construction will be the responsibility of the Contractor and will be repaired by the Contractor. The Contractor must take due caution in controlling pavement damage during necessary pavement cuts as discussed in other sections of these specifications. After back filling of the trench required, for a pavement cut, the Contractor will backfill and compact base material in accordance with Section 306 of the SCDOT Standard Specifications from ten (10) inches below the existing pavement surface to the point flush with the pavement. The Contractor will maintain the cut in good order until such time as the patching is completed. Immediately prior to patching, the Contractor will remove the back filled stone from the point flush with the pavement to the proposed two (2) inch depth of pavement. The Contractor will then trim pavement and cut edges to true line.

b. The pavement will be trimmed an additional six (6) inches beyond the trench edge to provide firm support on undisturbed material for the patch.

c. After removal of the stone and trimming of the edges, an asphalt primer will be applied at .25 to .45 gallons per square yard over the entire surface of the stone in the cut and allowed to set. Existing asphalt surfaces contacted with the new asphalt will have applied a thin coat of hot asphalt cement or asphalt thinned with naptha immediately prior to placing of the asphalt. Asphalt joints shall be cut back to form a bond with freshly mixed asphalt and chilled asphalt. for asphalt thicknesses greater than three (3) inches, the asphalt will be placed in two lifts. The depth of the asphaltic concrete patch will be placed in a minimum of two (2) inches lifts and placed flush with the existing asphalt surface.

d. For longitudinal cuts in pavement, the cut will be patched and the entire width of the roadway will be resurfaced for the longitudinal length of the cut. The depth of the resurfacing will be as required by Right-of-way owner.

e. Damage to pavement as a result of exceeding trench width regulations discussed in other sections or in the opinion of the Engineer or the Authority, as a result of Contractor carelessness during construction operations outside the immediate pavement area, will be the responsibility of the Contractor and will be repaired by the Contractor at no cost to the Owner or the Authority.

2.3.5 Maintenance of Existing Drainage

a. The Contractor will be responsible for maintaining drainage in all project areas during the course of construction. The contractor will be responsible for damage due to flooding as a result of construction practices. The contractor will take precautions to minimize erosion during construction.

b. The Contractor will be responsible for back filling, re-establishing turf, and restoring all properties including swales, ditches, culverts, etc. to a condition equal to or better than the original, to facilitate drainage.

c. For lines installed under culverts, the Contractor will provide 2,000 psi concrete arch encasement from the spring line of the proposed pipe to four (4) inches above the bottom of the culvert or use D.I.P. as directed by the Engineer or Authority's representative. If the minimum distance between the top of the proposed pipe and the bottom of the culvert exceeds the radius of the culvert, the contractor will compact soil around and above the line to 95 percent of the maximum density (modified Proctor) and place 2,000 psi concrete from four (4) inches below the bottom of the culvert to a depth equal to the culvert radius or use D.I.P.

EROSION:

Provisions shall be made to prevent erosion and siltration caused by construction, temporary grassing, hay bales, silt fences or other methods called for on the plans or as may be required, shall be used.

2.3.6 Vegetation and Grassing

The Contractor will take precautions to avoid any unnecessary damage to trees, shrubbery or other vegetation in the right-of-ways.

Shoulders, swales, easements, and other similarly disturbed areas will be grassed if required by the Engineer, the Authority or the Owner in accordance with Section 810 "Seeding" of the SC Department of Transportation Standard Specifications for

Highway Construction and as follows: The following would apply if required by the Engineer, the Authority, or the Owner.

a. Seeding schedules will be as specified in SC Department of Transportation Standard Specifications for Highway Construction Section 810 for permanent vegetation - lower state.

b. Commercial fertilizer following ground preparation will be applied at a rate of 500 lbs. per acre.

c. Seeding shall be uniformly sown in accordance with seeding schedules within 24 hours of application of fertilizers.

d. Straw or hay mulch will be uniformly applied at a rate of 2 tons per acre. Emulsified asphalt RS-2 diluted with an equal amount of water will be uniformly applied over the mulch at a rate of .20 gallons per square yard. As an alternate method of seeding, wood cellulose fiber mulch shall be applied at a rate of 1,500 pounds per acre in a mixture of seed and fertilizer with hydraulic equipment in accordance with SC Department of Transportation's Standard Specifications for Highway Construction Section 810.17, Method

e. A satisfactory stand of perennial grass as permanent vegetation will be developed.

f. Restoration and clean-up will follow immediately after backfill operations.

2.3.7 Unpaved Roadways

Unpaved or gravel highways of SCDOT, county or local municipality will be stabilized for the top twelve (12) inches of backfill with crushed stone or coquina mixed with binder after back filling in accordance with Section 2.2.3 Site Grading, Back filling and Compacting and compacted flush with the roadway. Any other unpaved road, side road, driveway, or other area presently stabilized by use of rock material will be stabilized with four (4) inches of crushed stone or coquina after back filling, in accordance to Section 2.2.3 Site Grading, Back filling, and Compacting.

2.3.8 Traffic Maintenance Safety and Control

The Contractor must maintain at least one lane of traffic at all times and no trenches will be left open over night. The contractor will receive permission from the local SCDOT Maintenance Engineer or the appropriate representative of the county or local municipality having jurisdiction prior to closing of a roadway. Work will be conducted so as to assure the least possible obstruction to traffic. The convenience of the general public and residences adjacent to the property are of prime importance and shall be provided for in an adequate and satisfactory manner.

All obstructions in right-of-ways will be protected by the Contractor providing signs, barricades and lights. Signs and flagmen in the construction area will comply with the 1972

SCDOT Manual of Uniform Traffic Control Devices for Streets and Highways, latest revision and all subsequent addendums. All trenches which traffic will pass over will be maintained in a condition that will allow normal vehicular traffic to pass over. Temporary access drives will be provided when necessary.

BARRICADES AND WARNING SIGNS:

The contractor shall erect, mark and maintain suitable barricades to protect and maintain public safety. Barricades, warning signs and other safety devices shall meet the requirements of OSHA, South Carolina Department of Transportation and GSWSA requirements. No work will commence until the contractor has secured approval for the agency responsible for the right-of-way in which construction is proposed.

2.3.9 Acceptance of Work

Upon completion of the project, a certification of acceptance of work along the public right-of-way or easement will be obtained by the Contractor from all authorities having jurisdiction over right-of-way or easement encroached upon during the course of the project and submitted to the Engineer and/or the Authority prior to final payment.

2.3.10 Warranty

The Contractor will provide a certificate of guarantee to the Authority for all materials and equipment furnished and work performed, for paving, drainage, grassing and other construction in public right-of-ways and easements for a period of one (1) year from the date of the Engineer's certification of work and/or authorization for service. For work requiring SCDOT approval on a SCDOT right-of-way the guarantee will be for one (1) year from the date of certification by SCDOT.

2.3.11 Dust Prevention

Disturbed roads in the construction area will be maintained for dust prevention by water or dust preventative treatment. The contractor shall comply with all applicable environmental regulations.

CHAPTER 3

GRAVITY SEWER SPECIFICATIONS AND DESIGN CRITERIA

3.1 GENERAL

Sewer capacities should be designed for the estimated ultimate tributary population, except in considering parts of the systems that can be readily increased in capacity. Similarly, consideration should be given to the maximum anticipated capacity of institutions, industrial parks, etc.

In determining the required capacities of sanitary sewers, the following factors should be considered:

a. Maximum hourly domestic sewage flow;
b. Pump station capacities and interceptor sewers from point of discharge to the treatment works;
c. Inflow and groundwater infiltration;
d. Topography of area;
e. Location of sewage treatment plant;
f. Depth of excavation; and
g. Pumping requirements.

The basis of design for all sewer projects shall accompany the plan documents. More detailed computations may be required by the Authority for critical projects.

3.2 DESIGN CRITERIA

3.2.1 Design Flow

a. Per Capita Flow: New sewer systems shall be designed on the basis of an average daily per capita flow of sewage of 100 gallons per day (.38 m3/day). This figure is assumed to cover normal infiltration; but an additional allowance should be made where conditions are unfavorable. Design flows per residential unit currently approved by DHEC for the Authority service areas are:

		Number of Bedrooms		
Treatment Facility	**NPDES**	**3 BR**	**2 BR**	**1 BR**
Schwartz	SC0037753	250	150	125
Vereen	SC0041696	250	150	125
Centenary	ND0069361	300	225	150
Conway	SC0021733	300	225	150
Bucksport	SC0040886	300	225	150
Lake View	ND0083097	300	225	150
Lake View	SC0022284	300	225	150
Loris	SC0025348	300	225	150
Longs	SC0040878	300	225	150
Green Sea Floyds	ND0066516	300	225	150
Marion	SC0046230	300	225	150
Mullins	SC0029408	300	225	150
Myrtle Beach	SC0039039	300	225	150
Nichols	SC0041327	300	225	150

b. Peak Design Flow: Sanitary sewer shall be designed on a peak design flow basis during one of the following methods.

c. The ratio of peak to average daily flow of 2.5 as required by the South Carolina Department of Health and Environmental Control.

d. Values established from an infiltration/inflow study acceptable to the Authority.

e. Use of other values for peak design flow will be considered if justified on the basis of extensive documentation.

3.2.2 Size

Size diameter of sewer mains shall be adequate to handle all future loading, not just existing loading. All sewer mains shall be eight (8) inches or larger in diameter. Sewers shall be laid with straight alignment and uniform slope between manholes. When a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. an approximate method for securing these results is to place the 0.8

depth point of both sewers at the same elevation. Sewer extensions should be designed for projected flows even when the diameter of the receiving sewer is less than the diameter of the proposed extension.

For all domestic wastewaters and for industrial wastewaters with solids which are similar in size and nature to solids in domestic wastewater, no gravity sewer line conveying raw sewage shall be less than eight (8) inches in diameter. In cases where the flow and number of taps are limited to less than ten (10) percent of the design capacity of the receiving sewer line, as determined by the Authority and the line cannot be reasonably extended, the Authority may consider the use of six (6) inch diameter lines.

3.2.3 Slope

All sewers shall be designed and constructed to give mean velocities, when flowing ½ full, of not less than 2.0 feet per second, (0.61 m/s), where velocities greater than 15 feet per second are attained, special provision shall be made to protect displacement by erosion and shock. Minimum allowable gradient shall be 0.33 percent for 8", .28 percent for 10" and .22 percent for 12" pipe. All designs should provide adequate additional slope to accommodate field variations. In all manholes a minimum 0.1 foot of drop shall be provided from invert in to invert out.

For all domestic wastewaters and for industrial wastewaters with solids which are similar in size and nature to solids in domestic wastewater, all gravity sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than two (2) feet per second, based on Manning's formula using an "n" value of thirteen thousandths (0.013). Slopes slightly less than those required for the two (2) feet per second velocity, when flowing full, may be permitted. Such decreased slopes shall only be considered where the depth of flow shall be three tenths (0.3) of the diameter or greater for average flows. Whenever such decreased slopes are selected, the design engineer shall furnish with the report design computations of the anticipated flow velocities of average and peak flows. The report shall indicate the actual velocity in the sewer lines at the proposed slope and the actual velocity at the required slope in order to achieve two (2) feet per second, when flowing full. The pipe diameter and slope shall be selected to obtain the greatest practical velocities to minimize settling problems. Oversized sewers shall not be approved to justify using flatter slopes. The operating authority of the sewer system shall give written assurance to the Authority that any additional sewer maintenance required by reduced slopes shall be provided.

Sewers on twenty (20) percent slopes or greater shall be anchored securely with concrete anchors or equal, spaced as follows:

a. Not over thirty six (36) feet center-to-center on grades twenty (20) percent and up to thirty five (35) percent;

b. Not over twenty four (24) feet center-to-center on grades thirty five (35) percent and up to fifty (50) percent; and
c. Not over sixteen (16) feet center-to-center on grades exceeding fifty (50) percent.

3.2.4 Depth

In general, sewers should be sufficiently deep to receive sewage below the floor elevation of all structures receiving service and maintain a minimum of 36 inches of cover, unless otherwise approved.

3.3 PROTECTION OF DOMESTIC WATER SUPPLIES

3.3.1 Water Supply Interconnection

There shall be no physical connections between a public or private potable water supply system and a sewer, or appurtenances which would permit the passage of any sewage or polluted water into the potable supply. No water pipe shall pass through or come in contact with any part of a sewer manhole.

3.3.2 Relation to Water Works Structures

a. Horizontal Separation: Sewers shall be laid at least 10 feet (3.0 m) horizontally from any existing or proposed water main. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten foot separation, the appropriate reviewing agency may allow deviation on a case by case basis, if supported by data from the design engineer. Such deviation may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so that the bottom of the water main is at least 18 inches (46 cm) above the top of the sewer. (See standard detail drawing for installation).

b. Crossings: Sewer crossing water mains shall be laid to provide a minimum vertical distance of 18 inches (46 cm) between the outside of the water main either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main and both water and sewer mains shall be D.I.P. (See standard detail drawings for installation). c. Special Conditions: When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to water pipe, and shall be pressure tested to assure water tightness. AWWA C900 for low pressure sewer force mains may be used for locations applicable to this.

3.4 PIPE MATERIAL AND APPURTENANCES

3.4.1 General Information

a. All materials used in the construction of sewers shall be new and unused when delivered on-site and shall be suitable for installation and operation under the conditions for which they are to be used.

   All materials will be delivered, stored, and handled in a manner as to protect the materials from damage. All pipe and appurtenant items should be handled as according to manufacturer recommendations with mechanical equipment and no pipe or appurtenant items will be dropped or pushed into trenches.

   Materials will be stored in such a manner as to prevent damage to the materials or the storing structure and prevent injury to persons. Equipment will also be protected from damage as necessary. All pipe and appurtenant items shall be protected from damage and inspected for defects prior to installation. Any foreign matter shall be removed from the pipe prior to installation.

b. Casing pipes and/or polyethylene pipe shall be installed at:

   1. Railroad crossings, as directed by railroad;
   2. Highway crossings, as directed by SCDOT, or;
   3. As designated by the Authority. (See standard detail drawings for installation requirements).

c. No sewer line of any type shall be allowed to pass through any storm drainage structure, unless approved by GSWSA.

3.4.2 Pipe Depth and Type Selections

a. On depths 18 inches to 3 feet of cover over the pipe, use D.I.P. with special interior lining, Protecto 401 ceramic lining.

b. On depths of 3 to 12 feet use PVC SDR-35. (Gravity sewer lines)

c. On depths of 12 feet and greater use PVC C900 DR 18 or approved equal. (Gravity sewer lines) Thirteen foot lengths of C900 may be manufactured and supplied for gravity sewer (deep installations) as long as it is appropriately marked as not having the standard plant AWWA hydrostatic test. Mark said pipes for gravity sewer where the lettering C900 regularly appears on the pipe. All other markings and manufacturing requirements for C900 are applicable as a substitute to the standard 20 foot lengths of PVC C900.

d. Pipe enclosed in casings shall be PVC C900 DR 18 with Bell restraints per State Highway regulations. (See standard drawing detail for installation with pipe supports and restraints).

3.4.3 Pipe Material Specifications

a. Prior approval shall be received for all uses of ductile Iron Pipe for sewer applications.

b. Ductile iron gravity piping, if approved, and fittings shall not be less than thickness class 50, meeting the requirements of ANSI A21.50 (AWWA C150) with a standard outside coating of bituminous coal tar epoxy and outside lining. Interior of ductile iron for gravity sewer service shall be coated with a Protecto 401 ceramic lining unless otherwise approved. Pipe shall have push-on-joints, mechanical joints, flanged joints, or restrained joints as required. Pipe joints including gaskets shall meet the requirements of ANSI A21.11 (AWWA C111). Fittings shall meet the requirements of ANSI A21.10 (AWWA C110).

c. Polyvinyl Chloride Gravity Piping: All PVC gravity sewer pipe and fittings shall meet the requirements of: ASTM D3034 (SDR35), Type PSM Polyvinyl Chloride (PVC) sewer pipe and fittings, 4" through 15".

   All PVC gravity sewer pipe 18" through 27" shall conform to ASTM F-794, F-679 and/or Uni-Bell B-4PS46, Perma-Loc or approved equal.

d. Third Party Certification: The manufacturer shall be subject to random inspection and evaluation by an independent third party in order to assure the purchaser to full compliance with this specification. The third party shall report all findings to GSWSA upon request. The third party selection shall be subject to the approval of GSWSA and shall be provided at no charge.

e. Testing: GSWSA shall have free access to that part(s) of the manufacturer's plant involved in work performed to meet requirements of this recommended standard. The manufacturer shall afford the inspector, at no charge, reasonable facilities needed to determine if the pipe meets the requirements of this recommended standard. GSW&SA shall have the right to plant inspection for witness testing and conformance to all specifications; all costs including transportation and lodging and meals is to be born by the manufacturer.

f. All sewers shall be designed to prevent damage from superimposed loads. Proper allowance for loads on the sewer shall be made because of the width and depth of trench where necessary to withstand extraordinary superimposed loading, special bedding, concrete cradle or special construction may be used.

3.4.4 Shop Drawings

The contractor will submit shop drawings as may be specified by the Engineer and the Authority for all pipe and appurtenant items. For piping, the Contractor will submit a notarized sworn statement from the manufacturers stating that inspections and all specified tests have been made and the results comply with the appropriate standards set forth in these specifications.

3.4.5 Service Laterals

a. Service laterals shall be installed where required to provide a connection from the sanitary sewer to the abutting lots. In general, house sewers shall be constructed from the lateral sewer to a point located at property line.

b. Service laterals shall consist of either 4-inch or 6-inch diameter D.I.P. or PVC and conform to the requirements of these service specifications. Service wye shall be installed at the end of each service lateral and plugged in a manner to allow for testing. Depth shall be a minimum of 36" to a maximum of four feet below finished grade or as determined by GSWSA inspector, (See Standard Details).

c. Service laterals when necessary to connect to a manhole shall be installed so the crown of main sewer line and service lateral are the same elevation. Service laterals shall not be connected to manhole where connection to main line can be made.

d. Service laterals to serve 9 REUs or less shall be 4", 10 REUs or more shall be 6" sewer laterals or as approved by the Authority.

e. Service laterals shall be installed on proper bedding to required grade and backfilled with suitable material to 2/3 the height of the pipe prior to inspection.

f. Excluding service connections less than fifty thousand (50,000) gpd, sewer connections to gravity sewer lines shall be constructed such that the internal angle of deflection is equal to or greater than ninety (90) degrees, including connections at manholes. Angles less than the required ninety (90) degrees may be considered on a case-by-case basis, when there is adequate justification (e.g., drop through the manhole) provided.

g. Service laterals shall have clean-outs installed at intervals of 75' maximum on straight runs, at all bends greater than 45°, at 5' from the building and at the property line adjacent to the sewer main.

3.4.6 Wyes and Tees

a. Wye and Tee branches shall be installed in sanitary sewer lines as required. If such branches are not to be used immediately they shall be closed with plastic stoppers as specified by manufacturer for the sewer pipe.

b. If the work consists of the construction of a sewer that is to replace an existing sewer all of the existing service lines shall be connected to the new line by a method approved by the Authority prior to construction.

c. Wyes and tees shall be installed in sanitary sewers so as to properly serve each existing house and each vacant lot facing or abutting on the street or alley in which the sewer is being laid, and at such other locations as may be designated by the Authority. The exact location of each connection shall be determined by the Engineer or the Authority before back filling.

d. Wyes and tees shall be of the same material and strength as the sewers on which they are installed. Molded fittings shall be used where available.

e. See Standard Drawing S25 for deep sewer lateral installations (C900 required). PVC fittings shall have gasketed bells and be compatible with PVC pipe made to AWWA C900. They shall have a wall thickness no less than that of the same size DR18 PVC pipe made to AWWA C900. Fittings in sizes through 8" shall be molded in one piece, and have minimum bell depths as required by AWWA C907. Fittings 10" and larger may be fabricated from DR 18, Class 150, PVC pipe meeting the requirements of AWWA C900. Gaskets shall conform to ASTM F-477. PVC material shall have a cell classification of 12454 as defined in ASTM D-1784. Fittings shall be manufactured by The Harrington Corporation of Lynchburg, VA or approved by GSWSA equal.

3.4.7 Marking Wyes, Tees and Service Laterals

The location of all wyes, tees, and service laterals installed in the work shall be marked with a 4" x 4" x 5' treated wood post painted green. (See Authority Marking Detail).

3.4.8 Connections to Existing Sewers

Connections to existing manholes shall be made in the presence of the Inspector. Contractor shall notify the Authority 48 hours before starting on connection.

3.4.9 Drop Pipe Manholes

A drop pipe should be provided for a sewer entering a manhole at an elevation of 24 inches (61 cm) or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches (61 cm), the invert should be filleted to prevent solids deposition.

Drop manholes should be constructed with an outside drop connection only.

Due to the unequal earth pressures that may result from the back filling operation in the vicinity of the manhole, the outside drop connection at the base, shall be encased in gravel bedding and properly supported prior to back filling.

3.5 MANHOLES

3.5.1 General

a. Manholes shall conform in shape, size, dimensions, materials, and other respects to the details indicated on the drawings or bound in the specifications or as ordered by the Engineer or the Authority.

b. Manholes shall be pre-cast reinforced concrete pipe manhole sections with tongue and groove joints. Manholes shall conform to the requirements of ASTM Specifications C478. Concrete used in their manufacture shall have a 28-day compressive strength of not less than 4,000 pounds per square inch and the absorption shall not exceed six (6) percent. Pre-cast concrete manholes must conform to ASTM C-478, latest revision.

c. Manhole sections shall be free from large honeycomb, cracks, spalds, large chips, exposed reinforcing, and broken bells or spigots. Allowable deviation in form joints shall be ¼". Edges of bells and spigots shall be even and straight.

d. All manholes shall be reviewed during design with the Authority.

e. Where the difference in the invert elevation of two or more sewers intersecting in one manhole is two feet or more, a drop manhole shall be constructed. They shall be similar in construction to the standard manhole except that a drop connection of pipe and fittings of the proper size and material shall be constructed outside the manhole and supported by gravel bedding. (Refer to Paragraph 3.4.9)

f. Where the work requires special stream or railroad crossings or other extraordinary conditions, or where alternate types of construction are those that are not covered by these specifications, the materials and construction methods shall be submitted for approval to the Authority.

g. Where shown on the drawings, drop manholes shall be constructed in accordance with the standard details.

h. Pre-cast-reinforced concrete manhole sections shall be set so as to be vertical and with sections and steps in true alignment.

i. No potable water pipe shall pass through or come into contact with any part of a sewer manhole.

j. Manholes shall be installed: at the end of each line; at all changes in grade, size, or alignment; at all intersections of piping; and at distances not greater than four hundred (400) feet for sewers fifteen (15) inches or less, and five hundred (500) feet for sewers eighteen (18) inches to thirty (30) inches. Distances up to six hundred (600) feet may be approved, for sewers equal to or greater than eight (8) inches in diameter, in cases where adequate cleaning equipment for such spacing is provided. Greater spacing may be permitted in larger sewers. Cleanouts may be used only for special conditions and shall not be substituted for manholes except when installed at the end of laterals not greater than one hundred fifty (150) feet in length.

3.5.2 Minimum Wall Thickness

The minimum inside diameter of manholes shall be forty eight (48) inches unless using an inside drop connection where a minimum inside diameter of sixty (60) inches shall be required for all new manholes. For modifications to existing manholes, a minimum diameter of forty eight (48) inches, for inside drop connections, may be provided if justified and approved by the Authority. A minimum manhole access diameter of twenty two (22) inches shall be provided.

The minimum wall thickness of the manhole riser sections shall be:

4' Diameter Manhole	4" Minimum Wall Thickness
5' Diameter Manhole	5" Minimum Wall Thickness
6' Diameter Manhole	6" Minimum Wall Thickness
8' Diameter Manhole	8" Minimum Wall Thickness
10" Diameter Manhole	10" Minimum Wall Thickness

Cone Sections shall have a minimum wall thickness of 8" at their top.

3.5.3 Base Sections

Base riser sections shall be made with bottoms cast monolithically.

Bottoms cast into already made pipe sections are not acceptable. The minimum thickness of the bottom shall be six (6) inches for manholes four (4), five (5), and six (6) feet in diameter.

3.5.4 Invert Openings

Suitable openings for inlet and outlet sewer pipe shall be cast or cored into the base sections and into riser sections for drop connections. These openings shall be circular, accurately made, and located as required for each manhole. Base riser sections shall be set on compacted pipe embediment materials twelve (12) inches in thickness. Flexible manhole sleeves or flexible manhole entrance joints shall be installed on all pipe entering and leaving manholes. Flexible manhole sleeves shall be installed on all pipe 16 inches in size and smaller. Flexible manhole sleeves shall be of high quality synthetic rubber terminating in a substantial serrated flange of the same material. The flange shall be secured to the wall of the manhole base to form a tight water-stop. Minimum thickness of the sleeve material shall be 3/8 inch. Sleeve material shall comply with the requirements of ASTM Specification C-923. Sleeves shall be secured to the sewer pipe to make a watertight union with stainless steel strap clamps, draw bolts, and nuts.

3.5.5 Steps

Manhole steps shall be constructed of steel covered with polypropylene. The minimum tread width shall be 12 inches. The steps shall incorporate two non-skid grooves and shall be of the drop-front design. Polypropylene covered steel steps shall consist of a ½ inch diameter

Grade 60 steel reinforcing rod covered by corrosion resistance polypropylene plastic. The steps shall incorporate traction cleats and foot guide lugs. Steps shall be spaced 12 inches apart.

3.5.6 Riser Joint Seals

The manhole sections may be joined with either O-ring seals or butyl rubber type sealer. If O-rings are used, they shall conform to ASTM C443 and shall be set in a rectangular groove cast into the tongue section of each manhole. O-rings shall be installed as recommended by the manhole manufacturer. If butyl rubber sealer is used it shall be "Ram-Nek" joint sealer or equal. "Ram-Nek" shall be set on only clean and dry surfaces and placed as recommended by the manufacturer. (See sample details) In both cases, after manhole sections are jointed, the inside and outside of the bell and spigot joint shall be covered with a smooth tapered coat of pre-mixed non-shrink grout to a thickness of ½ inch at the joint.

3.5.7 Manhole Invert Construction

Manhole inverts shall be constructed of cement grout and shall have the same cross-section as the invert of the sewers they connect. The manhole invert shall be carefully formed to the required size and grade by gradual and even changes in sections.

Changes in direction to flow through the sewer shall be made to a true curve with as large as radius as the size of the manhole will permit. Concrete brick will be used to form the invert channel walls only. All annular space shall be filled with concrete grout only. Inverts shall be "U" design with top of "U" even with the crown of the pipe (see details). Invert piping shall not extend inside manhole any further than 2 inches. Slope of inside of invert benches shall be a minimum of 2" higher than the crown of the pipe. When dissimilar pipe sizes occur, the elevation of the crown of the pipes must be the same.

3.5.8 Casting Date

Manholes will be scored or stamped with date of casting, and manufacturer's name.

3.5.9 Manhole Frames and Covers

a. Manhole frames and covers shall be made of cast iron conforming to ASTM Specification A-48 Class 35B. All castings shall be made accurately to the required dimensions and pattern. The castings shall be sound, smooth, clean and free from blisters and other defects. Castings which have been plugged or otherwise repaired shall not be acceptable for use. The contact surface between the cover and supporting ring shall be machined to make contact on the complete perimeter. Covers shall have cast in lettering as follows "Sanitary Sewer".

b. Frames and covers shall be U.S. Foundry 668 Ring and K L Cover or approved equal. The top shall have a vent hole and two non-penetrating pick holes. Where waterproof

manhole frame and covers are required, U.S. Foundry 579 Ring and DC-SSG cover or approved equal shall be used. Frames and covers in paved roadways or parking lots shall be extendable via extension rings such as U.S. Foundry No. 2334 or 2335, or approved equal.

c. All castings shall be dipped with 24 mil coal tar epoxy paint with smooth, drip-free finish, free of surface cracks.

d. Leveling and final grading of manhole frames and covers shall be accomplished by using a maximum of two concrete grade rings or three courses of brick concrete. Grade rings shall not exceed 4" in thickness. Concrete grade rings shall be laid in a full bed of non-shrink grout and covered after laying with a smooth coating of non-shrink grout or hydraulic cement a minimum of ½ inch thick. The top elevation of all manholes must be above the fifty (50') year flood plain or be of waterproof construction.

e. When a manhole is located in an unpaved non-traffic area, the frame and cover shall be adjusted to an elevation 1" to 3" above the existing grade at the center of the cover. If field changes have resulted in the complete manhole invert to be greater than the invert shown on the drawings and the cover higher than 5" above existing grade, then the top of the eccentric cone, when used, or the top of the barrel section, when used, shall be trimmed down so that the manhole cover, after installation, is not greater than 5" above existing grade at the center of the cover. The area around the adjusted frame and cover shall be filled with the required material, sloping it away from the cover at a grade of one-inch (1") per foot.

f. Manholes located in unpaved roadway areas (sand/coquina) shall remain approximately 4" below finish grade. Concrete markers shall be installed for manhole locating.

g. Inflow protectors shall be installed on all manholes per the most recent GSWSA requirements for manufacture and type approved.

3.6 SYSTEM TESTING

3.6.1 General

The Authority will require that all sanitary sewer systems pass the following test prior to acceptance by the Authority.

3.6.2 Air Testing

a. The Contractor shall conduct low pressure air tests on all completed sections of gravity sewer. The air test results will be used to evaluate materials and construction methods on the sewer line sections and shall be in accordance with ASI C 828-75T.

b. The Contractor shall furnish an air compressor which will provide at least three hundred cubic feet of air per minute at one hundred pounds per square inch along with all

necessary plugs, valves, pressure gauges, air hose, connection and other equipment necessary to conduct the air tests. Plugs in sewers 18 inches in size and larger shall be connected by cable for thrust reaction. The sewer section shall be plugged at both ends and air pressure shall be applied until the pressure inside the pipe reaches 4 psig above the pressure created by groundwater above pipe. When a stable condition has been reached, the pressure shall be observed and recorded.

If the time for the air pressure to decrease from 3.5 psig to 2.5 psig is equal to or greater than that shown in the following table, the pipe shall be presumed to be free from defect. When these times are not attained, pipe breakage, joint leakage, or leaking plugs are indicated and the cause must be determined and corrected. After repairs have been made, the sewer sections shall be re-tested. This process shall be repeated until all sewer sections pass the air test

AIR TESTING Allowable Timetable		
Diameter of Pipe (In.)	Time per 100ft Pipe	
	Minutes + Seconds	
4	0	18
6	0	42
8	0	48
10	1	6
12	1	30
15	1	42
18	2	24
21	2	32
24	3	30
27	3	48
30	4	48
36	5	54
42	7	18
48	8	31
54	9	48
60	11	6

3.6.3 Deflection Test

a. Deflection tests shall be performed on all pipe. The test shall be conducted after the final backfill has been in place at least 15 days. At the discretion of the Authority, twenty percent of the lines may be selectively tested. If no failures are observed, no further test may be required.

b. No pipe shall exceed a deflection of 5 percent.

c. If the deflection test is to be run using a rigid ball or mandrell, it shall have a diameter equal to 95% of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices. The contractor is responsible for providing mandrell and associated equipment at the time of inspection.

3.6.4 Leaking and Infiltration

All pipe joints shall be watertight. Infiltration of groundwater or other leakage into the sewer (including manholes) shall not exceed 200 gallons per mile of sewer per inch of inside diameter of the sewer per 24 hours in any section of the completed work. The infiltration rate into each section of the sewer shall be measured by the temporary installation of suitable metal or wooden weirs as authorized by the Authority. These weirs shall be furnished, installed, and removed by the Contractor. Any leaks into the sewer shall be located, repaired and corrected. The testing methods selected should take into consideration the range in groundwater elevations projected and the situation during the test. Infiltration/exfiltration cannot exceed 200 gallons/day/inch of pipe diameter/mile of pipe.

3.6.5 Inspection

The specifications shall include a requirement for inspection of manholes for water tightness prior to placing into service. Prior to inspection, all lines must be flushed and cleaned.

3.7 GREASE TRAP TANKS

Grease trap tanks shall be constructed and installed per the most recently adopted standard detail drawing unless otherwise approved by the Authority.

CHAPTER 4

SUBMERSIBLE AND ALTERNATIVE LIFT STATIONS AND APPURTENANCES

4.1 DESIGN CONSIDERATIONS

4.1.1 Scope

The Engineer should submit the following design calculations:

a. Station service area ultimate loading.

b. Flotation calculation (weight of station without pumps vs. uplift).

c. Cycle time calculation maximum six (6) cycles/hour.

4.1.2 General

The contractor shall furnish and install a duplex submersible non-clog sewage pump station as shown on Contract Drawings, unless approved otherwise by GSWSA. See Standard Drawings for construction plans and details. The station shall include two (2) pumps, rail guides, wet well basin, mounting plates with sealed discharge flanges, access frame and covers with guide rail supports, and a separate set of pump cable support hooks, the pump pull out shall be cables and for up to 20 horse power pumps shall be 5/16" diameter; 316 stainless steel and 3/8" diameter, 304 stainless steel for in excess of 20 horse power pumps, hooks, pump controls, and all other accessories to make a completely automatic system. For domestic wastewaters and industrial wastewaters with solids which are similar in size and nature to solids in domestic wastewater, pump openings shall be capable of passing spheres of at least three (3) inches in diameter, for raw, unscreened wastewater, and pump suction and discharge piping shall be at least four (4) inches in diameter, except for grinder pumps.

The pump design shall be such that pumping units shall be automatically connected to the discharge connection, and shall be easily removed for inspection or service, requiring no nuts or bolts or other fasteners to be removed for this purpose and no need for personnel to enter the wet well. Each pump shall be fitted with screw type shackles as required for fastening each end, to permit lifting the pump for inspection or service.

A sliding guide bracket shall be an integral part of the pumping unit and the pump casing shall have a machined connection flange to connect with the cast iron discharge connection, which shall be bolted to the floor of the sump and so designed as to receive the pump connection flange without the need of any bolts or nuts. Sealing of the pumping unit to the discharge connection shall be accomplished by a simple linear downward motion of the pump with the entire weight of the pumping unit guided to and pressing tightly against the discharge

connection. No portion of the pump shall bear directly on the floor of the basin. No weight is to be supported on guide rails or the discharge connection.

The float conductor holding a rack shall be of a type approved by GSWSA and shall be separate from the lifting pump cable support hooks.

Pump impeller shall be either single or double blade non-clog type, constructed of high grade material. Each pump shall contain two (2) shaft seals running in an oil chamber. The lower seal, between the pump and the oil chamber, shall contain one stationary and one positively driven rotating tungsten carbide ring. The upper seal unit, between the oil sump and motor housing, shall contain one stationary tungsten carbide ring and one positively driven rotating carbon or carbon-ceramic ring. For all pumps over 40 Hp or if required for warranty of motor, an electrical probe shall be provided in the oil chamber. This probe shall establish an electrical circuit when the oil in the chamber becomes contaminated with water. The electrical circuit shall turn on a warning light in the control panel warning of leakage past the lower seal. The pump parts, motor housing volute, cover, etc. shall be of high-tensile gray iron construction. The pump and motor shaft shall be of 400 Series stainless steel. All fasteners shall be type 303 Stainless Steel.

The motor control panel, power control panel and other electrical panels shall be mounted above the 100 year flood elevation.

4.1.3 Site Layout

Each pump station shall be fenced or secured in a locked building/enclosure or be located in a restricted access area to prevent access by unauthorized persons. The type of fencing or other means of controlling access shall be approved by the Authority.

A weather durable sign, approved by the Department, with a twenty four (24) hour emergency telephone number, shall be located at a conspicuous point on the fence or structure of the pump station, unless the pump station is located in a restricted access area.

Pump stations shall be designed to be fully operational during flooding to the twenty five (25) year flood elevation unless the influent flow into the pump station can be stopped. For example, industrial facilities may select to cease operation during these periods in lieu of having the pump station fully operational.

Wet well and above ground appurtenances shall be located in such a manner as to provide an adequate unobstructed area within fence for placement of emergency generator and bypass pumps. The pumper bypass connector system shall be the same size as that of the proposed force main. Final size and location to be determined by GSWSA. The elevation of the pump station site shall be equal to or greater than the adjacent roadway. Pump station access shall not be located on major highways.

4.2 PUMPS AND MOTORS FOR SUBMERSIBLE STATIONS AND CONC. WET WELL

4.2.1 Approved Pumps

Acceptable pump manufacturers for submersible pumps are Flygt, Myers, ABS, ShinMaywa or Approved Equal. All pumps 25 horse power or greater shall utilize soft start controls.

4.2.2 Pump Design Specifications

Pumps shall be equipped as follows. No other manufacturers shall be used without prior approval. All pump removal equipment (slide rails etc.) shall be similar in installation with existing GSWSA pump stations so that the above approved pumps may be interchanged between stations. Flygt or approved equal.

a. Pumps shall be designed to handle peak flow with the largest pump out of service.
b. Motors shall be non-overloading over entire pumping range. Motors shall have thermo overloads.
c. Motors shall have Class F (155 degree C) insulation and withstand Class B (130 degree C) temperature rise with a service factor of 1.5 at the efficient point of the curve.
d. Motor rpm shall not exceed 1800 rpm's. Wire to water efficiency curves shall be submitted for approval.
e. Three (3) phase power shall be required on all motors. No "add-a-phase" systems shall be allowed. Upon special approval for special and unique applications, single phase motors will be given consideration.
f. Unbalanced voltage on motors under load shall not exceed 1.0% when measured at the motor terminals. Voltage shall be read with an accurate digital voltmeter; and recorded as part of the final inspection; calculations shall be NEMA Standard MG1-1972 (See Vol. la-11, No. l, Jan/Feb 1974 IEE Transaction Industrial Application).
g. Power factor correction shall be required to 85% for all 20 Hp and larger motors.
h. Lightning arrestors are required for all services.
i. Pump and motor shall have a minimum of 400 series S.S. shaft on motors under 10 HP. Motors above 10 HP can have a chrome plated steel shaft.
j. Impeller shall be keyed to shaft and be single or double vane.
k. Pump volute shall have replaceable wear rings.
l. Seals shall be tungsten carbide to tungsten carbide or carbon-ceramic.
m. B-10 bearing life shall be a minimum of 40,000 hours.

n. Pump and motors shall have adequately sized stainless steel lifting cables; length shall reach top of station plus an additional six (6') feet. Adequate designed lift chain hooks (2) shall be imbedded into top slab and situated to facilitate easy removal of units.

o. All piping shall be thickness class D.I.P. cement lined and all fittings shall be ductile iron rated at a working pressure of 250 psi. All pipe shall be American Cast Iron Pipe Company or equal. All valves shall be eccentric plug valves with open left valve stem operation.

p. Motors larger than 40 Hp or if required for motor warranty shall be equipped with moisture detection probe and have moisture detection indication lamp mounted on control panel.

q. Motor shall be equipped with overheat sensor and shall shut down the motor. Control panel shall have separate indicator lamp for overheat shutdown.

r. Motor shall be wired for lead-lag operation and shall be equipped for alternate cycle operation.

s. Each motor shall have a separate run time totalizer and HOA switch.

t. Pumps shall be installed per manufacturer's recommendations above wet well bottom.

u. Each pump shall be tested at the factory and certified by the manufacturer. Pump manufacturer to provide written performance certification curves with operating flow and total dynamic head conditions for each pump.

v. Pumps shall be designed to operate within the acceptable B.E.P. (best efficiency point) as noted on the pump performance curve. The minimum accepted operating point is 50% of the B.E.P.

4.2.3 Pump Warranty

The pump manufacturer shall warrant the pumps, electrical controls, and all system components against defects in workmanship and materials for a minimum period of one (1) year under normal use, operation and service.

4.2.4 Access Frame and Cover

A single or double door access frame assembly shall be cast in top slab of the station. Covers shall be fabricated of aluminum with stainless steel hardware minimum size acceptable shall be 36" x 42". Frame shall support guide rails and be securely mounted over the pumps. Cover shall be provided with lifting handle and safety latch to hold the cover in the 90 degree open position. Locking hasps/lugs shall be provided for cover. Cover shall be of the checkered plate design. Lower guide bar holders shall be integral with the discharge connection. Guide bars shall be stainless steel pipe. Cover shall comply with ASTE Std. H-20 if located in areas

with vehicular traffic. Access frames and covers shall be per the pump suppliers slide out rail package specifications.

4.2.5 Ball Check Valve

The contractor shall furnish and install ball check valves of the type and size indicated on the drawings. The valves shall consist of a gray cast iron Class 35 body and cover and a hollow steel ball with a vulcanized nitrile rubber exterior. The ball check valve will have one moving part. The design of the valve shall be such that it keeps solids, stringy materials, grit, rags, etc. moving without the need for back flushing. The ball shall clear the waterway providing "full flow" equal to the nominal size. It shall be non-clog. There shall be no outside levers, weights, springs, dash pots or other accessories required for a swing (clapper) type check valve. The ball shall be resistant to grease, petroleum products, animal and vegetable fats, diluted concentration of acids and alkalines (ph 4-10) tearing and abrasion. Flange drilling shall be according to ANSI B 16.1, Class 125. The ball check valve will be installed in a vertical position as shown on the plans. If shown, the valve shall be of the type shown on the plans. Ball check valve shall be Flygt or approved equal.

4.2.6 Liquid Level Controls

Level Control system shall be as specified in 4.2.10 with the level set points as follows.
Level Control System

1. Off: Set above the pump impeller.
2. Lead-lag differential of a minimum of one (1') foot.
3. Alarm setting one (1') foot above the lag setting.
4. Influent pipe a minimum of six (6") inches above the alarm setting.
5. In addition to above, one float shall be provided for a high level alarm for back-up in the event of failure.

4.2.7 Valve Box

a. Lift station must be equipped with valve boxes similar to the one shown in sample pump station details.

b. Each pump discharge line shall have a ball check valve, an eccentric plug valve, and a M.J. coupling that is placed in a manner that facilitates removal of fittings. The eccentric plug valve shall be located outside of the wet well in a separate valve pit or other apparatus (e.g., valve box) to facilitate proper use of the valve. In certain cases, the Authority may require watertight design of the pit or other apparatus for the purpose of capturing valve

leakage. For watertight design, it shall have a means of dewatering (e.g., drain line) back to the wet well, with provisions for preventing gases from entering the pit from the wet well.

c. The force main shall have an eccentric plug valve to prevent force main back flow, when a shut down of a pump is required.

d. An emergency pump connection shall be provided in the forcemain just beyond the pump eccentric plug valve. It shall consist of a tee with an eccentric plug valve and an authority approved quick coupling. (See standard drawing). In addition, a plug valve shall be installed on the force main between the pump manifold piping and the pump station fence line.

e. All bolts, nuts and washers shall be hot-dipped galvanized rust resistant steel.

f. Access cover shall be aluminum equipped with stainless steel hasp and hinge and large enough to provide clear access to all fittings.

4.2.8 Pump Station Wet Well

The basin shall be constructed of pre-cast concrete manhole barrels and a poured reinforced concrete top. Manhole barrels shall conform to the requirements set forth in manhole section. The wet well shall have watertight joints with the method of sealing meeting the requirements of the Manhole Section. See size, location and details per Contract Drawings and Standard Details. The following is a list of basin conditions:

a. Minimum allowable wet well diameter shall be 6’-0” I. D. See 4.12 for Grinder Pump station.

b. The bottom slab of the wet well shall be set on a 12” or thicker bed of crushed stone. All over-excavated areas below the wet well bottom shall be filled with Class B concrete.

c. Wet well bottom shall be constructed to provide a hopper bottom. Concrete bricks may be used as filler to form hopper bottom provided minimum of 6” grout cover is maintained. The pump manufacture recommendation for inlet clearance at bottom of pump shall be adhered to.

d. Top of the concrete slab shall be one (1’) foot above the 100 year flood elevation and no less than adjacent roadway to prevent drainage problems.

e. Steps shall not be used in wet wells. Contractor shall provide a heavy duty aluminum or fiberglass extension ladder capable of extending from the bottom of the wet well to a height of 4 feet above top of wet well.

f. Influent line shall terminate a minimum of ½” and a maximum of 3” inside the basin. Access hatch and hook for hoisting cable shall be cast into the top of the wet well.

g. All hatches shall be aluminum with stainless steel hasp and hinges sized and located per pump Manufactures recommendation.

h. A 4" vent pipe shall be installed in top slab as shown on standard drawing and shall contain 1/8" mesh 316 stainless steel bug screen.

i. All bolts, nuts, and washers in wet well shall be Type 302 stainless steel.

j. The interior wet well wall and bottom of top slab shall be coated and/or lined for corrosion protection. Coating and/or liner application for use will be determined by GSWSA. Coatings are required for regular wet well installations. Submittals are required for approval. Coatings shall be Spectrashield, Mainstay, Protective Lining, Raven Lining Systems, or approved equal. Coating thickness selection to be by Authority. Said coatings shall receive acceptance of installation prior to any water filling and/or operations of pump station. All coatings and work shall be in conformance with the manufacturer's application requirements. Walls and under slab shall receive said applications of coatings. Lining Systems for wet wells shall apply to major large size re-pumping lift stations. The various concrete large diameter wet well sections will have the liner cast at the supplier's yard, however for the portions of liner work needed to form the final interior liner joint, the wet well supplier will provide for the installation of said final joint heat fusion welding. The contractor (wet well installer) shall coordinate this work and allow for the wet well supplier's crew, the required access and time needed to perform the work. All work applicable to the liner installation shall be completed and accepted by the owner prior to the contractors installation within the wet well of any mechanical or piping equipment. The wet well installing contractor shall complete all joint grouting and necessary leak stoppage for water tightness and have said work approved by GSWSA prior to authorization for the field liner work to begin. The liner shall be polyethylene by Taylor Precast Carolina, AGRU Grip or T-Lock by Tindall. A Raven Lining System may be substituted for the polyethylene if approved by the Authority. Submittals and approvals are required for all wet wells.

k. Piping within the pump station shall be no less than 4" diameter including ball check valves, discharge elbows and plug valves.

l. Discharge piping exiting wet well shall be no more than 36" below top slab of pump station.

m. The flange adapter within the pump station wet well shall be the 2100 MegaFlange® Restrained Flange adapter as produced by EBAA Iron, Inc. or approved equivalent.

4.2.9 Electrical

a. Pump and motor shall be shipped with non-wicking electrical power cable, over heat cable and seal failure cable. If seal failure probe is supplied, it shall be factory installed and tested. Cut ends are to be sealed and tagged at the factory for shipping. See Section 4.7 ELECTRICAL SERVICE MATERIALS for additional requirements, if applicable.

b. All electrical cable from the motor and wet well level sensors shall be terminated in the control panel. No junction boxes will be allowed for sensor cables.

c. Power cable within wet well shall be supported using Kellems single eye closed mesh support grips (sized for cable diameter) and attached to the pump cable support hooks.

d. Conduit shall be PVC. Conduit leaving the wet well box shall have a gas tight seal.

e. Electrical control panel mounting frame shall be made entirely of aluminum or stainless steel above ground and adequately grounded.

f. Concrete pad shall be provided for by the electrical control panel 4 ft. x 8 ft. installed per standard detail.

g. Lighting arrestors shall be provided for all services.

4.2.10 Standard Duplex Control Panel

a. Electrical control panel shall be NEMA 4X stainless steel, with three-point latch and drip shield. Panel shall be large enough to house all control equipment. The panel shall be equipped with a pad-lockable door handle. A separate weatherproof lockable main disconnect is to be installed adjacent to the control panel. Panel shall be mounted on aluminum posts and frame per standard drawing detail.

1. Provide a back-panel attached to the enclosure on collar studs, and adequately sized to accommodate all control components.
2. Mount components to back panel securely utilizing screws, washers etc.
3. Back-panel to be painted with two coats of white epoxy
4. All control wiring to be routed through wire duct on back-panel in a neat and orderly fashion.

b. Level Control shall be provided by the following method:

Multitrode Level Control System:

1. Provide an MTIC or equal Indicating controller
2. Provide a Model 3.0/10 sensor with sufficient length of cable
3. Provide MTAK-1 or MTAK-2 mounting hardware for probe
4. The MTIC indicating controller is to be wired to act as the primary control device for the control panel. Provide (4) four relay outputs from the MTIC to provide “OFF’, “LEAD”, “LAG” and High Level alarm functions in a typical LEAD/LAG sequence of operation.
5. The relays are to be wired to the MTIC in such a manner as to provide a method for the operations personnel to change the level at which the respective set-points will activate based on liquid level.

6. Provide a 4-20ma signal from the MTIC to the SCADA RTU for level indication proportional to the level of liquid on the probe.
7. Provide an additional "HIGH" level float to activate the high-level alarm circuitry. This float circuit shall utilize a low voltage source not to exceed 24 volts. Cable length must be adequate

The panel shall have a hinged interior dead front door with a minimum of thickness of .010" mounted with a continuous stainless steel piano hinge. The inner door shall have a minimum swing of 90 degrees when open. It is to have some method of latching to keep it closed when panel is not being serviced.

The following components are to be mounted on the interior door:

1. Hand-Off-Automatic selector switch for each pump
2. Lead1, Lead 2, Alternate selector switch
3. 6 digit non-re-settable elapsed time meter for each pump
4. Indicating lights for:
    - Pump running
    - Motor over temperature
    - Seal failure (if required by pump supplier)
    - Float failure (if utilizing float control system) wired to terminals for connection to RTU

    Pushbuttons for the following:

    - Alarm test
    - Float fail reset (if utilizing float control system) wired to terminals for connection to RTU (NC contact)
    - Starter overload reset mechanism
    - Reset seal alarm (if required by pump supplier)
    - Alarm / horn silence
5. GFI receptacle, 115V, 15A on separate 15 amp breaker
6. Main, Emergency and Pump breakers shall be accessible through interior door for operation by operators.

c. A minimum of the following components shall be mounted on the back-panel.
    1. Main circuit breaker (walking beam interlocked with emergency breaker)
    2. Emergency circuit breaker (walking beam interlocked with main breaker)

3. Pump motor #1 circuit breaker
4. Pump motor #2 circuit breaker
5. The following "DRY" contacts shall be provided for use by the SCADA RTU as follows and wired to terminals for connection to RTU:
    - High level alarm (closes on alarm)
    - Three Phase Power failure (open on alarm condition)
    - 120 volt control power failure alarm (opens on alarm condition)
    - 24 volt power failure if float system is used (opens on alarm condition)
    - Float status for all float switches if float system is used (closed on float closure)
    - Pump run status for each pump (closes when pump is running)
    - Motor over-temp for each pump (closed on over-temp condition)
6. 4-20 ma signal (if Multitrode control method is used) shall be wired to terminal blocks for connection to SCADA RTU.
7. NEMA rated motor starters with heavy-duty contacts, bi-metallic overload protection in each phase. IEC type starters will not be accepted.
8. Alternator relay (Diversified electronics or equal)
9. Control relays with 10A minimum contact rating
10. Circuit breakers for the following:
    - Controls
    - Receptacle
    - SCADA RTU
11. Phase failure relay that will monitor phase loss, reversal, or low voltage. This relay is to be wired into the control circuitry in a manner that will drop out the pump motor starters if any abnormal condition as mentioned above is detected. Phase monitor must be of design that it will automatically reset itself when the power problem is corrected.

    SEE SECTION 4.9 FOR COMPONENT SPECIFICATIONS

d. An alarm horn and a flashing alarm light with a minimum of 40W light bulb shall be installed on the panel. Alarm light shall be approved for vapor tight installations and should be Ingram Products model LRX-40 or equal. Alarm light is to be mounted in a position for full 360-degree visibility. Alarm horn and light shall be activated upon a high wet well level. Their circuitry shall be designed so that they will de-activate automatically when the alarm condition has cleared.

e. Control sequence shall be designed that the panel functions automatically when power is restored again after a power failure and manual reset is not necessary.

f. A high temperature circuit shall be provided that will provide a shutdown for each individual pump in the event of a high temperature condition. A "red" indicator light indicating the high temperature condition shall be provided on the inner door. The circuit shall automatically reset its-self when the high temperature condition has cleared.

g. The control panel manufacturer shall provide provisions for remote control of the pumps via the SCADA RTU. An over-ride circuit that will allow the RTU to force on or remotely stop both pumps individually shall be designed into the control circuitry of each pump. These circuits shall be employed on the "automatic" side of the Hand-Off-Auto switches. Additionally, the force on circuit shall not defeat any protective devices within the control circuitry of the control panel such as phase loss, high temperature etc. Also the force on circuitry shall not function if the Hand-Off-Auto switch is in the "OFF" mode. All wiring for these circuits shall be wired to terminals for external connection to the SCADA RTU.

h. Seal failure relays shall be electronic type with a maximum of 24v, 0.5ma, 5VA Signal Power.

i. A complete assembly for an electrical emergency connection assembly shall be provided for all pump control panels. For 240 volt, up to 100 amp applications, use Crouse Hinds APQ1047 and for 480 volt, up to 200 amp applications use Appleton AR20044. Generator connector shall be mounted on the side of the controller in a position that can be easily accessed by maintenance personnel. If the application requires the use of the APQ1047 connector because of the voltage requirements and the full load current of the control panel exceeds 100 amps, an interlock circuit shall be utilized on the emergency breaker as to disable one of the pump when the generator is connected to and supplying power to the panel.

j. All control wiring to be MTW 90 deg. C #14 AWG.

k. All wiring should be neatly grouped in plastic wire duct except wiring from the back panel to the door, which shall be done in a separate bundle with protective spiral wrap protecting it from sharp edges etc. that it may cross.

l. All wires shall have wrap around or sleeve type wire identification number as shown on wiring schematic at both ends of the wire.

m. All components shall be identified with a label applied to the back-panel corresponding to the number shown in the wiring schematic

n. All door-mounted components shall have engraved nameplates. (Refer to Section 4.6 EQUIPMENT IDENTIFICATION AND APPROVALS).

o. All conduits entering the control panel must be sealed.

p. All electrical work shall be performed by licensed personnel.

q. Electrical permits etc. shall be applied for at the Code Enforcement Office having jurisdiction in the area where the project is being installed.

r. All installation shall be in accordance to the National Electrical Code

s. Electrical supply, control and alarm circuits shall be designed to provide strain relief and to allow disconnection from outside the wet well. Terminals and connectors shall be protected

from corrosion by location outside the wet well. NO CABLES OR WIRING SHALL BE SPLICED INSIDE THE WET WELL UNDER ANY CIRCUMSTANCES. Avoid junction box whenever possible. If at all possible, route all cables directly from wet well into control panel without the use of junction boxes, etc.

t. The control panel shall be located outside the wet well and protected by a conduit seal or other appropriate measure meeting the requirements of the National Electrical Code, to prevent the atmosphere of the wet well from gaining access to the control panel.

u. Pump motor power cord shall be designed for flexibility and serviceability under conditions of extra hard usage and shall meet the requirements of the Mine Safety and Health Administration for trailing cables. Power cord terminal fittings shall be corrosion-resistant and constructed in the manner to prevent the entry of moisture into the cable, shall be provided with strain relief appurtenances and shall be designed to facilitate field connection.

4.2.11 Variable Frequency Drive Pump Control Panel

This section refers to variable frequency drive duplex or triplex pump control panels. Variable frequency drive controllers shall be of programmable solid state design.

4.2.11.1 General

a. Manufacturer

The manufacturer shall provide data, upon request, that it has a minimum of five (5) years experience in the production of pump control panels. The manufacturer shall have a test facility to allow three phase line voltage testing of the completed panel at the rated service voltage.

b. Material

All electrical components and materials supplied shall function as a complete unit to automatically control the pump down of the wet well. All devices and material shall be new and of standard product design.

c. UL Rating

The control panel enclosure shall be in accordance with Underwriters Laboratories (UL) and must bear the manufacturer's UL label for enclosures to indicate and qualify same.
The control panel assembly and wiring shall be in accordance with Underwriters Laboratories UL508 and bear the UL label. Electrical work shall be in accordance with the latest edition of the National Electric Code and subject to local codes.

d. Manufacturer Nameplate

There shall be permanently affixed to the inside of the exterior enclosure door a nameplate indicating the voltage, phase, horsepower, order reference number, date manufactured and the control panel manufacturer's name, address and telephone.

e. Wiring

All power wire shall be stranded and sized as required for load and application according to the NEC. All control and signal wire shall be a minimum of #14 AWG, 90 degree insulated and color coded. Colors shall be red for all AC control, blue for all DC control, yellow for external source control, white for AC neutral and green for equipment ground wiring. All wiring on the rear of the controls panel shall be neatly bundled using tie wraps or other means. All internal wiring on the back plate shall be neatly routed in wire duct with removable covers. All wiring shall be continuous point-to-point (no splices) and be totally accessible with permanent number marking on each end to match the control schematic drawings.

f. Quality Control and Testing

The panel shall be manufactured using quality workmanship and components. Upon completion of the panel it shall be completely factory tested. All control and alarm operations shall be performed with external signals simulated to insure proper operation. The three phase line voltage source for which the panel is intended shall be used for testing.

4.2.11.2 Panel Operation - Duplex Pump Control

The control panel shall provide power and logic control to operate two (2) motor driven submersible pumps at 480 volt, three phase, four wire, 60 hertz. The control voltage shall be 120 volt, one phase.

The control logic shall provide for the automatic start/stop and variable speed control operation and alternation of the lead pump under normal conditions. Within the operating parameters of the pumps, as the influent flow rate increases and the wet well level rises, the speed of the lead pump shall increase proportionally to the level. As the influent rate decreases and the level falls, the speed of the lead pump shall decrease to maintain a relatively constant wet well level.

If the influent flow rate causes the lead pump to reach or exceed full speed pumping capacity and the level continues to rise, the lag pump shall automatically start and operate with the lead pump. Both shall operate at the same required speed to handle the current flow. As the influent flow rate increases and the wet well level rises, the speed of both pumps shall simultaneously increase proportionally. As the influent rate decreases and the wet well level falls, the speed of the pumps shall decrease.

At a wet well level below the pumping capacity of the two pumps the lag pump shall shut off and the speed of the lead pump shall increase to handle the current flow. At an influent flow rate low enough to lower the wet well level sufficiently to reduce the lead pump speed to minimum speed, the lead pump shall shut off. In the event of a pump failure or a flow that exceeds the full speed capacity of both pumps, a high alarm level shall operate a red general alarm light and an audible alarm horn on the exterior of the panel. An alarm silence push button shall silence the horn. The pump designated as lead pump shall alternate each duty cycle as a function of the pump controller. The pump alarms covered herein shall be operational at all times to monitor the pumps' operation and protect the pumps.

The unit operating environment shall be rated at an ambient operating temperature of 0 degrees C. to 40 degrees C. without de-rating and a relative humidity of 5 to 95% non-condensing. The unit shall allow for a 3,300 ft. elevation without de-rating. The storage environment ambient temperature shall -25 deg. C. to 65 deg. C.

4.2.11.3 Enclosure

NEMA - 4X with 3 point latch and drip shield, stainless steel, or fiberglass. The pump controls shall be housed in an enclosure as specified. For large pump house type applications, the enclosure shall be freestanding type with steel channel base and back plate mounting studs. It shall be sized to house all the required components and allow adequate space for testing and maintenance.

The enclosure shall have padlocking provisions in addition to the door latches and continuous hinge of stainless steel. The door gasket shall be continuous rubber composition with a molded in spring steel retainer for attachment to the enclosure without the use of adhesives to provide a positive oil and dust door seal. Ventilation shall be provided to insure the adequate dissipation of heat generated by the VFD units and solid state controls. The air intake vent openings shall have stainless steel grills with filters and adequate 120 volt exhaust fans that shall also have inside guards. The fans shall operate on a line voltage thermostat. The air exhaust vent openings shall also have stainless steel grills with filters.

For standard exterior pump station applications, the pump panel shall be mounted on aluminum post and frames per standard detail shown.

Emergency Connector - A complete assembly for an electrical emergency connection assembly shall be provided for all pump stations. For 100 amp use APQ1047 and for 200 amp use AR 20044. GSWSA shall be contacted prior to installation for approval of location and final configuration of mounting in conjunction with the main pump control panel.

4.2.11.4 Power Distribution

The panel power distribution shall include all components as indicated below and be completely wired with stranded conductors having a minimum of 90 degree insulation rating and an ampacity rating a minimum of 125% of the motor ampere rating. All power wiring shall be neatly routed and totally accessible. All conductor terminations shall be as recommended by the device manufacturer and be secure to provide adequate electrical conductivity.

4.2.11.5 Pump Motor Circuit Protectors

The pump motor breakers shall be motor protector magnetic trip devices and provide for individual motor disconnect and short circuit protection as required by the NEC for motors when used with motor starters. The breakers shall have a continuous ampere rating as indicated on the drawings that shall not exceed the NEC rating for motor branch circuit protection. The magnetic trip rating shall be adjustable and the voltage rating shall be 600 volt. The breaker handles shall be totally accessible through the inner door. Breakers shall be Square D type, KA Mag-Guard. Breaker lock-out devices must also be installed.

4.2.11.6 Motor Control Drives

An AC adjustable frequency controller shall be supplied to control the speed of a squirrel cage induction motor. The controller shall be Danfoss Aqua 8000 Adjustable Frequency Controller as manufactured by Danfoss Electronics and shall include the following minimum functions, features and ratings:

4.2.11.7 Basic Controller

A. An input (circuit breaker or fusible disconnect switch) shall be supplied to provide NEC required branch circuit protection. The (breaker or switch) shall be an external operator.

B. Current limiting fuses shall be installed in the controller input.

C. A rectifier stage shall change fixed voltage, fixed frequency, AC line power to a fixed DC voltage. The rectifier shall consist of six power diodes in a three phase, full wave bridge, configuration. The rectifier shall be insensitive to the phase rotation of the AC line and shall not cause displacement power factor of less than .95 lagging under any speed and load condition.

D. An invertor shall change fixed DC voltage to variable frequency, variable voltage, AC for application to a standard NEMA design B squirrel cage motor. The invertor shall utilize IGBZT Technology.

E. The controller shall be rated to operate in an ambient temperature of 0. deg. C. to 40 deg. C. continuously. Installation at altitudes less than 3,300 feet above sea level shall not require de-rating.

F. The controller shall be capable of supplying 115% of rated full load current for one minute at maximum ambient temperature.

G. The controller shall be designed to operate from a (460V) + 10%. 5% three phase, 50/60 Hertz supply and control a motor with a corresponding voltage rating.

H. Acceleration and deceleration time shall be independently adjustable from 1 second to 3600 seconds.

I. Adjustable full-time current limiting shall limit the current to a preset value which shall be adjustable from 60-115% of the controller rated current. The current limiting action shall maintain the V/Hz ratio constant so that variable torque can be maintained. Overload trip-adjustable 0-100% of rated output current.

J. 1-50 HP Type EVT controller shall be capable of producing an output frequency over the range of 3 to 60 Hertz (20 to 1 speed range), 3 to 90 Hertz (30 to 1 speed range) or 3 to 120 Hertz (40 to 1 speed range) without low speed cogging. 60-300 HP Type EVT Controller shall be capable of producing an output frequency over the range of 1 to 60 Hertz (60 to 1 speed range), 1 to 90 Hertz (90 to 1 speed range), or 1 to 120 Hertz (120 to 1 speed range) without low speed cogging. Over frequency protection shall be included such that a failure in the controller electronic circuitry shall not cause frequency to exceed 100% of the maximum controller output frequency selected (60, 90, or 120 Hertz).

K. Minimum and maximum output frequency shall be adjustable over the following ranges: 1. Minimum frequency to 50% of maximum selected frequency. 2. Maximum frequency 40 hertz to 60, 90, or 120, Hertz. 3. Voltage boost adjustable 100-400% of nominal N/Hz ratio @ 1.5Hz tapering to 100% @ 204 Hz.

L. The controller shall be capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

M. Protection of power semiconductor components shall be accomplished without the use of fast acting semiconductor output fuses. Subjecting the controller to any of the following conditions shall not result in component failure or the need to fuse replacement:

1. Short circuit at controller output
2. Ground fault at controller output
3. Open circuit at controller output
4. Input under voltage
5. DC bus over voltage

6. Loss of input phase
7. AC line switching transients
8. Instantaneous overload
9. Sustained overload exceeding 115% of controller rated current
10. Over temperature

N. Solid state motor overload protection shall be included such that current exceeding an adjustable threshold shall activate a 60 second timing circuit.

O. A slip compensation circuit shall be included which will sense changing motor load conditions and adjust output frequency to provide speed regulation of NEMA B motors to within +0.5% of maximum speed without the necessity of a tachometer generator.

P. The controller shall include static reversing which shall change the output phase rotation by changing the order of firing signals to the invertor switching devices. All logic necessary to accept a direction select contact shall be included.

Q. The controller electronics shall contain an operator interface to monitor and indicate the following conditions and to allow programming and configuration of the drive:

1. Drive lockout
2. Under voltage
3. Over voltage
4. Over temperature
5. Instantaneous over current
6. Ground fault
7. Power supply voltage Ok
8. Controller enabled
9. Current limit warning (motor mode)
10. Fault indication (input follower signal loss, dynamic braking fault, regeneration controller fault)

R. The controller shall be supplied in a NEMA Type motor control center style enclosure.

4.2.11.8 Bypass and ISO Contactor

Properly sized by-pass and ISO contractor will be provided to enable operation of pump in the event of VFD failure. Contractors will be Square D Class 8536 or approved equal.

4.2.11.9 Power Circuit Accessories

The panel power accessories shall include all components as indicated below and be completely wired with stranded conductors. All wiring shall be neatly routed and sized as required with a minimum of number 12 AWG.

4.2.11.10 Control Circuit Breaker

The 120 volt common control circuit shall be protected by an auxiliary one (1) pole circuit breaker. The convenience receptacle shall have a separate one (1) pole circuit breaker. The breaker handles shall project through the inner door.

4.2.11.11 Lightning Arrestor

The control panel shall have lightning arrestor protection included within the panel to protect the motors and control equipment from lightning induced line surges. It shall be 600 volt rated and be a three phase unit with connection to ground. The arrestor shall be mounted near the incoming power source and be properly wired to all three phases and ground.

The lightning arrestor shall be a General Electric 9L15ECC001 or an approved equal.

4.2.11.12 Surge Capacitor

The control panel shall have surge capacitor protection included within the panel to protect the unit from damaging transient voltage surges. The surge arrestor shall be mounted near the incoming power source and be properly wired to all three phases and ground. The surge arrestor shall be A General Electric 9L18BAB301 or an approved equal.

4.2.11.13 Phase Monitor Relay

A three phase monitor relay shall be installed to protect the motors. It shall be a three phase voltage sensing device that is adjustable for the system nominal voltage. It shall protect the control panel from loss of a single phase, even with a three phases simultaneously and phase sequence reversal. An output contact shall be wired in the pump motor starter control circuit.

Should the voltage fall below any of the parameters, after a one (1) second delay on dropout, the phase monitor shall shut off the pumps. The phase monitor shall automatically reset when nominal voltage is restored to allow the pumps to restart.

4.2.11.14 Duplex Convenience Receptacle

A GFCI receptacle shall be mounted on the controls mounting plate to provide a maximum of 15 amperes at 120 volt. The receptacle shall be a 15 ampere rated, three (3) wire grounding duplex type.

4.2.11.15 Control System

The control circuit shall provide for the automatic and manual control and alternation of the pumps to maintain a pumped down condition of the wet well. The control system shall sense the wet well level through a remote wet well level sensing solid state transducer. The transducer shielded cable shall be of sufficient length to be continuous from the panel terminals.

The set point elevations for the pump motor start/stop operation shall be as indicated on the drawings. All required control relays in addition to the solid state pump controller shall be multi-contact plug in type with track mounted bases.

The pump alternation shall be a function of the dedicated solid state pump controller unit and shall provide alternation after each duty cycle.

The pump controller shall receive the 4-20ma input signal from the wet well level transducer device and function to provide the discrete start/stop signal for sequencing of the pumps and provide the serial communication signal to the two variable frequency drive units for speed control reference. All of the above parameters shall be programmable from the operator interface without the use of additional devices or programmers.

The pump controller shall include alarm outputs for low wet well level and high wet well level. The low alarm level shall also function as a redundant off level for the pumps. The pump controller unit shall have a pump delay “on” and “off” timer to prevent simultaneous starting of both pumps.

Each pump shall have alarm indication and/or shutdown for motor thermal protection alarm, motor drive fault alarm, pump failure alarm and seal failure alarm.

The control system shall include, but not be limited to, the following functions and features.

4.2.11.16 Level Sensing Ultrasonic Transducer

The wet well level sending device shall be an ultrasonic transducer unit. The transducer shall generate a 4-20ma output signal directly proportional to the wet well level over the preset sending range. The unit shall have a zero adjustment of +/-10% of minimum span range and a span. The unit shall be preset as needed and require no field adjustments or settings to provide the input signal to the PLC.

4.2.11.17 Pump Controller - Programmable Logic Controller (PLC)

The pump controller shall be a dedicated solid state unit. The operator interface shall be flush mounted and provide all the operating sequence functions as needed, and shall allow the operator to change any setting from the unit keypad. The controller shall be capable of controlling and sequencing two (2) or three (3) pumps. The unit shall have a

two line, 32-character, alphanumeric LCD display and a 16-position keypad for operator interface. Controller will be Modicon Quantum Series, or a Model # 110 CPU -61200. The following functions and features shall be included:

A. Power Source

The source power shall be from a 120 volt isolation transformer rated UL Class 2 with a 120 volt secondary.

B. Analog Input Signal

The unit shall accept a 4-20ma analog signal from the wet well level sensing unit. The internal input analog signal shall be through a 12-bit binary A/D conversion. The controller shall provide conditioning of the analog input signal including spanning, offsetting, quelling (rate-of-change-limiting), full-scaled ranging and display.

C. Pump Control Set Points

A turn-on and turn-off set point adjustment shall be provided for two discrete pump control stages for differential operation in a pump down mode between the selected levels. Alternation shall be cycled each time all pumps are off and shall sequence the pumps in rotation. Each of the outputs shall have an open-collector load relay driver circuit at up to 100ma for control of each UL recognized load relay. The keypad shall allow setting the controlled pumps in a fixed sequence as an alternative operating mode to the automatic alternation.

D. Alarm Set Points

A turn-on and turn-off set point adjustment shall be provided for High and Low Level Alarm functions with display and relay outputs for each. A common alarm relay output shall also be included. Each output shall have an open-collector load relay driver circuit at up to 100ma for control of each UL recognized load relay.

E. Discrete Input Signals

The controller shall have sufficient discrete (ON/OFF) input circuits to accept external input contacts including two pump run auxiliary, two pump fault, low level alarm, low level alarm restore, alarm silence, phase failure and generator on line. The ON/OFF inputs shall be internally optically-isolated. These signals are used by the controller to monitor and react to the operating environment of the system.

F. LCD Display

The LCD display panel on the controller is a multi-function display. It can display the input analog signal in feet and tenths of the wet well level and the running pumps. The display can show the pump stage and pump driver operation, or display the VFD Ramp and Level Ramp percentiles. It can also display any alarms or the time and date. All other features and functions shall be capable of being displayed to provide visual monitoring and setting of all adjustable parameters. Operator interface to be approved by GSWSA prior to purchase.

G. Access Coding

The controller shall have an access code for protection against unauthorized change of adjustments. Any operator shall be able to view the adjustments, but changes shall only be possible through use of the confidential Access Code.

H. Pump HOA Selector Switches

A three (3) position selector switch mounted on the controls panel shall provide the Hand, Off or Automatic operating mode selection for each pump. The switches shall be oil-tight with 10 ampere rated contacts as required. A position indicating legend plat and an identifying engraved name plate shall be provided with each switch. In Hand position with pumps shall run continuously under the speed control of the manual potention meter subject only to low level shutdown. In Automatic position the pumps shall respond to the pump controller unit and start/stop at the preset wet well levels and with speed control subject and proportional to the wet level. In Off position the pumps shall be locked-out and not operate.

I. Pump Run Indicator Lights

A run pilot light shall be mounted on the controls panel for each pump to turn on when the pump VFD unit is on to indicate pump run. The pilot lights shall be 120 volt oil-tight type with a red lens.

J. Elapsed Time Meters

An elapsed time meter shall be mounted on the controls panel for each pump to record the accumulated running time of the pump motor. It shall run when the pump is operated in Hand or Auto mode. It shall be 120 volt non-resetable and record time in hours (6 digits) and tenths.

K. Control Terminal Blocks

Control terminal blocks shall be provided for the connection of all remote devices and signals. Each terminal block shall be legibly marked as indicated on the control schematic. The terminals shall be pressure plat screw type with a minimum of a #8 screw, and include an adequate barrier between terminals to provide a 600 V rating.

L. Alarm Systems

Each of the following alarm functions shall be included in the panel to continually monitor the specific condition for which it is intended and provide the indication and response described. The indicator pilot lights for all alarms shall be oil-tight, 120 volt with name plates to identify each function. These alarm functions are to protect the pumps and indicate abnormal conditions of the system.

M. Alarm Light

The exterior panel mounted alarm light shall be a weatherproof, shatterproof red light fixture with a 40 watt bulb to indicate an alarm condition exists. The general alarm light shall be turned on by any alarm function. An indicator pilot light on the inner door shall show which of the alarm conditions has caused the exterior general light to be turned on. The light shall turn off when the alarm condition is corrected and the alarm circuit is manually reset, if required.

N. Audible Alarm Horn

The exterior panel mounted audible alarm horn shall be a weatherproof device to provide an audible signal to indicate an alarm condition exists. The alarm horn shall be a minimum of 80 decibels and be turned on by any alarm function that will turn on the exterior alarm light. The audible alarm shall be silenced by depressing the Alarm Silence push button, located on the panel. The silence circuit shall automatically reset when the alarm condition is cleared.

O. High Level Alarm

The high level signal from the pump controller shall close on a low wet well level condition. A Low Level Alarm relay and an oil-tight red pilot light shall be provided to indicate the alarm condition. The general alarm shall turn on to indicate the alarm condition. The low level alarm relay shall also shut down all pumps, should they be running, as a redundant off level control. The general alarm and low level pilot light shall automatically turn off when the low level condition is corrected. There shall be a high, high level alarm.

4.2.11.18 Drawings and Markings

A. Panel Marking

All component parts in the control panel shall be permanently marked and identified as they are indicated on the control drawings. Marking shall be on the back plate adjustment to the component. All control panel conductors shall be permanently number marked with wire markers at each end as close as practical to the termination of the conductor.

B. Name Plates

The panel shall include engraved nameplates on the inner door for all components to indicate the device function. The name plates shall be permanently affixed with a bonding adhesive and shall be white with a black core, and have a minimum of 3/16” letters.

C. Final Drawings

Upon completion of the panel a complete set of As Built drawings and Bill of Materials shall be supplied to the owner. The drawings shall include a power and control schematic and a terminal block diagram showing each remote connection to the panel. An adhesive mylar copy of the schematic drawings and terminal diagram must be permanently affixed to the inside of the control panel door.

D. Submittal Drawings

The contractor shall provide a complete set of shop drawings as outlined in these specifications prepared by the manufacturer and submitted to the Engineer for review prior to the manufacture of the equipment. The shop drawings shall include power and control schematics, a terminal connection diagram and a panel layout with dimensions. A component Bill of Materials shall be submitted and include each component referenced, quantity, description, manufacturer and part number. The layout drawing must show the general arrangement and location of each component. The power and control schematic must show all component markings and wire numbers. The schematics

shall be specific for the control panel being considered and not general in nature. The terminal connection diagram must show all field connections and the devices to which they are connected.

After submittal review by the Engineer the drawings shall be returned marked and noted as to the evaluation. Only upon an Approval or Approved as Noted evaluation can manufacture of the panel proceed.

4.2.11.19 Final Installation and Start-UP

A. Manufacturer's Representative

The services of a factory trained, qualified representative of the pump supplier shall be provided to inspect the completed installation and make all adjustments necessary to place the system in trouble-free operation. The representative shall instruct the operating personnel in the proper care and operation of the equipment, prior to the final acceptance of the station.

B. Inspection

The completed station shall be tested and inspected for compliance to the contract documents. The testing shall be done by the contractor in the presence of the Engineer or his/her representative, the Owner's representative and the equipment manufacturer's representative. A thorough inspection of all mechanical and electrical equipment and controls, pumps, guide rails and brackets, piping, fittings, valves, sleeves, panel mounting, conduit, conduit seals, wiring, components, and features shall be made while the station is being tested to determine performance and compliance with design requirements and specifications.

C. Pumps Testing

Pumps shall be test run to insure proper motor rotation and pumping capacity. Any pressure tests required to evaluate the pumps shall be done and data recorded. Each pump will be tested and evaluated for proper operations against the manufacturers pump curve. The pump shall provide a shut off head within 5% of manufacturers curve. The field pressures obtained and the pumping flow rate shall be compared against the manufacturers pump curve. All pump accessories and guide rails shall be checked for alignment and proper operation. All valves and related components shall be checked and operated for proper operation.

D. Electrical and Controls Testing

All control operations for manual and automatic operation of the pumps shall be tested and evaluated. The station incoming voltage and the running amperage of each phase of each pump motor shall be recorded during testing. These readings along with the motor manufacturer data shall be evaluated and submitted to the Owner for a record. The controls shall be tested to determine satisfactory performance for the automatic operation and alternation of the pumps at the proper wet well levels including high and low alarm levels. The satisfactory operation of all pump and motor alarms shall be tested.

E. Acceptance

Upon completion of operation and testing of the station as demonstrated by the contractor the Engineer and Owner representatives shall offer their signature as having witnessed the satisfactory operation.

F. Guarantee

All equipment shall be guaranteed against defects in material and workmanship for a minimum period of one year from the date of Owner's final inspection and acceptance to the effect that any defective equipment shall be repaired or replaced, at the discretion of the supplier, without cost or obligation to the Owner.

4.2.12 Remote Telemetry Equipment

A Remote Telemetry Panel shall be provided. Enclosure to be NEMA 4x fiberglass or stainless steel enclosure. All PLC I/O connections are to be wired to terminal blocks for field connection to pump station control panel.

A minimum of the following items are to be monitored at the pump station:

- High Wet Well
- Pump Run Status
- Three Phase Power Status
- Control Voltage Status
- Pump Temperature Alarm (if provided in pump control panel)
- Pump Seal Failures (if provided in pump control panel)
- Pump Speeds if applicable
- Analog wet well level from ultrasonic level control or probe

Equipment shall consist of the following:

- Modicon 110CPU61200
- Battery back-up
- Lightning/surge protection for all power circuits (Innovative Technology or approved equal)
- Appropriate power supplies for PLC and radio equipment
- Radio Equipment:
- One of the following radios to be used in the RTU. This selection will be based upon the location of the pump station. Final approval to be by GSWSA Operations and Maintenance Division prior to purchase.
- Microwave Data Systems Model 9710B with 4800 bland internal modem and loop back diagnostics.

- Antenna supporting structure to be Rohn 25C tower or treated utility pole at approximately 30' of height above ground with antenna approximately 35' above finished ground elevation.
- Coaxial Cable to be Andrew 1/2" foam (minimum)
- Coaxial connectors to be compatible with radio and antenna connectors
- Polyphaser surge/lightning protection to be supplied on antenna coax
- Antenna to match frequency of approved radio
- Antenna and coaxial cable shall be properly grounded

4.2.13 Spare Parts for Pump Stations

Contractor shall furnish to the engineer on or before final inspection one (1) each of the following:

1. Seal assembly: one (1) complete set for one pump.
2. Bearings: one (1) compete set of bearings for one pump.
3. Two (2) complete sets of record drawings for wet well, electrical, electronic schematics and pump O&M manuals with factory pump curves for pumps installed, copies of all certified test data (if certification is required) and inspection data.

4.2.14 Ladder

Contractor shall furnish a heavy duty aluminum or fiberglass extension ladder capable of extending from the bottom of the wet-well to a distance of 4' above hatch opening on top slab. Ladder shall be rated for 375 pounds.

4.2.15 Fall Protection

Contractor shall furnish fall protection designed to provide fall through protection per OSHA standard 1910.23 and controlled confined space entry per OSHA standard 1910.146.

The safety gate shall be made of 6061-T6 aluminum with a minimum ultimate strength of 38,000 psi. and a minimum yield strength of 35,000 psi., as per A.S.T.M. B221.

Grating shall be designed to withstand a minimum live load of 300 pounds per square foot. Deflection shall not exceed $1/150^{th}$ of the span.

Design shall assure that the fall through protection is in place before the doors can be closed.

Each gate shall be designed with a permanent hinging system which will lock the gate in the 90 degree position once opened. Gates in the open position shall create a physical pedestrian barrier around the opening.

Each gate shall have an opening arm with vinyl grip handle and designed to accommodate a controlled confined space entry lock.

Grate shall be painted with an OSHA type safety orange paint.

Welding shall be in accordance with ANSI/AWS D1.2-90 Structural Welding Code for Aluminum.

4.3 SITE CONSTRUCTION

4.3.1 Site Layout

Pump Station site shall be in accordance with approved site plans.

4.3.2 Site Ground Cover

The entire site shall be covered with 8 mil black polyethylene covered with 6" of compacted class I rock or coquina. This covering should extend 1' outside the fence line.

4.3.3 Electrical Service

Power pole should be located within the fenced area and should be located in such a manner so the electric meter can be easily read from outside the fenced area. All power lines within the site shall be underground. No overhead power line will be allowed to cross the site. Transformer shall be located outside of fence.

The Contractor shall furnish all labor and materials necessary and shall install, complete and ready for use, the electric power and control/system as indicated on the Drawings and as herein specified.

All electrical equipment and details of installation shall comply with the requirements of the latest revisions of the following codes and standards:

a. National Electrical Code (1984 edition)
b. National Electrical Safety Code (ANSI C2)
c. State and Local Codes.

4.3.4 Service Road

Site shall be serviced by an all-weather road with 6" compacted Class I rock or coquina. Top of road shall be above the twenty-five (25) year flood elevation. Road and site drainage shall be included and approved by appropriate agency. (See Sample Detail.)

Service road should be large enough to accommodate two (2) vehicles either in parallel or series to remain clear of vehicular traffic.

All concrete sidewalks within pump station access road shall be 8" in thickness.

4.3.5 Water Supply

A 1" water service line, water meter, dual check valve assembly and 1" non-freeze, non-polluting yard hydrant shall be supplied on site. Water metering is not required at pump station sites in GSWSA's water service area.

4.4 SITE FENCING AND GRASSING

4.4.1 General

The Contractor shall perform all work necessary for or incidental to the performance and completion of fencing, where fencing is required. This work shall be completed as shown on the drawings and as specified by the Authority. This work shall include the furnishing of all labor, materials, and equipment. The contractor shall be responsible for coordinating the work to assure that the work is completed in an orderly manner.

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

4.4.2 Chain Link Fence Manufacturing and Materials

Chain link fence installed on this project will meet or exceed all applicable standards of the Chain Link Institute. Fencing provided will be of new materials only and all fabric, posts, gates, post tops, tension wire, bars, rails, bands, braces, fittings, fasteners and all other items necessary will be one reputable manufacturer.

All items will be hot dip galvanized steel except fabric which may be aluminum coated. Materials will be fabricated and welded prior to coating. The fencing will consist of the following: Fabric will be one piece six (6) feet in width and will consist of no. 9 gauge wire woven in two (2) diamond mesh with barbed selvages at top and bottom. Fabric will consist of zinc coated steel or aluminum coated steel. Zinc coated will be in accordance with ASTM A 392, Class I.

"Zinc Coated Steel Chain Link Fence Fabric", and will require 1.2 oz. of coating per square foot (S.F.) of wire surface area. Aluminum coated will be in accordance with ASTM A 491, Class II and will require 0.40 oz. per SF of wire surface area.

Brick fencing may be substituted for chain link however design drawings must be submitted for approval.

4.4.3 Posts

a. Line posts will be 2 ½ inch outside diameter (O.D.) galvanized steel pipe weighing not less than 3.65 lbs. per linear foot (LF); or 2 ½ inch square tubing or 2 ¼ inch H-Sections weighing not less than 4.1 lbs. per LF.

b. Gateposts will be three (3) inch O.D. galvanized steel pipe weighing not less than 5.79 lbs. per foot for gates up to six (6) feet in width.

c. Corner, pull and end posts or terminal posts will be three (3) inch O.D. galvanized steel pipe or 2 ½ inch square tube weighing not less than 5.79 lbs. per LF. Corners will be considered as changes in direction of thirty (30) degrees or more. Pull posts will be used at abrupt changes in grade. Posts will be sufficient length to be set in thirty-six (36) inches of concrete as shown on the plans. Steel pipe will be galvanized in accordance with ASTM A 120 (1.8 oz zinc per SF) Steel, weather tight post caps will be provided for each post.

d. Bracing rails will consist of 1-5/8 inch O.D. galvanized steel pipe weighing not less than 2.27 lbs. per LF. Bracing will be between terminal posts and adjacent line posts and installed midway between the top rail and the ground level. Pipe will be galvanized in accordance with ASTM A 120 (1.8 oz. zinc per SF).

e. Stretcher bars for attaching fabric to terminal posts will be flat bars of a cross section of 3/16" x ¾" steel consisting of one piece equal to the height of the fabric. Stretch bars bands will be No. ll gauge sheet metal spaced at fifteen (15) inches on center and bolted with 3/8 inch diameter bolts. Stretcher bars will be provided at one bar for each gate and end post and two for each corner and pull post. Bar and bands will be galvanized in accordance with ASTM A 120 (1.8 oz per SF).

f. Tension wire for attaching the fabric to terminal posts will be No. 7 gauge spring rolled steel galvanized with 0.8 oz. of zinc per SF of surface and spaced twenty-four (24) inches on center. Fabric bands will be No. 9 gauge wire or straps galvanized steel or aluminum for attaching fabric to line posts and top rails.

g. Fittings will be of malleable steel, cast iron or forged steel, rigid and weatherproof and suitable size for strong construction. Included will be a forty-five degree bracket to accommodate three strands of barbed wire.

h. Barbed wire will consist of two (2) strands of No. 12 ½ gauge wire with 14 gauge 4 point barbs in accordance with ASTM A 121 with Class 3 zinc coating and spaced five (5) inches O.C.

i. Gates will be double swing 12' wide or as otherwise approved by the Authority. Gate frames will be constructed of galvanized steel pipe not less than 1 7/8 inch in diameter and weighing not less than 2.72 lbs. per LF or square tubing weighing not less than 3.65 lbs per LF. Frames will be bolted, riveted or welded with welds provided with an application of zinc based paint. Fabric will be as previously specified and will be attached with spacing not exceeding fifteen (15) inches. Gate hinges will be of pressed or forged steel or malleable iron of adequate strength with large bearing surfaces for clamping or bolting in position. Hinges will be offset to permit 180 degrees gate opening. Hinges will

not deform under the action of the gate. Gate latches will be a plunger-bar arranged to engage the center gate stop and for locking with padlocks. Keepers will be provided to engage the gate leaf and hold it open until manually released. A drop rod on the latch with casing set in concrete will be provided. The gates will swing out and be capable of being easily opened and closed by one person.

4.4.4 Chain Link Fence Erection

Erection of the fence will be in full accordance with the standards of the Chain Link Institute, ASTM F 567 and manufacturer recommendations and will be by experienced, skilled mechanics. Final grading of the site will be along straight lines, and set plumb with posts spaced at a maximum distance of ten (10) feet. Post holes will be drilled in firm, undisturbed or compacted soil. The Contractor is responsible for verifying suitability of soil conditions prior to installation. For posts less than six (6) inches in diameter, holes will be twelve (12) inches in diameter for terminal posts and nine (9) inches for line posts to a depth of forty (40) inches below grade. Posts will be set in a concrete foundation completely filling the hole to a depth of thirty-six inches below grade with four (4) inches of concrete below the bottom of the post. The top of the concrete foundation will be shaped to drain water.

Horizontal brace rails and diagonal truss rods (3/8”) brought to proper alignment. Top rails will be installed with expansion couplings providing rigid connections allowing expansion and contraction. Top rails will be anchored to main posts with proper fittings. The fence framework will be firmly fit.

Fabric will be installed from two (2) inches above grade at the bottom to the top of fabric at the top rail. The fabric will be stretched tight and fastened to end posts with stretcher bars and clamps and to line posts and top rails with wires or bands. The fabric installed on the security side of the fence. Fabric will be free of sags or bulges and secured to posts at fifteen (15) inches O.C. and to top rails at twenty-four (24) inches O.C. Three strands of barbed wire will be installed on the brackets of the fence and gate, tightened and fastened on each bracket. Brackets will be angled away from the security side of the fence. Gates will be erected rigidly without sagging, twisting or loose fittings and hung plumb and level. Hardware will be adjusted to provide smooth opening and closing of the gate.

4.4.5 Site Grassing

The Contractor shall perform all work necessary for or incidental to the performance and completion of site landscaping, when required for specific projects. This work shall be completed as shown on the drawings and as specified. This work shall include the furnishing of all labor, materials, and equipment. The Contractor shall be responsible for coordinating the work to assure that the work is completed in an orderly manner.

Although such work may not be specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound,

secure, and complete installation shall be furnished and installed as part of this work. Site shall be covered with ground cloth and a minimum of 6" of compacted SABC.

4.4.6 Acceptance of Payment

Before acceptance of the grassed areas, the Contractor shall be required to produce a stand of perennial grass sufficient to survive dry periods and winter weather and capable of re-establishment in the spring. Grasses shall be strongly growing of good color, disease free, and of a density sufficient to provide visible evidence of strong resistance to erosion. Stands of grass shall not be satisfactory if the bare spots exceed the following limits: more than 10 percent of any 1,000 square feet area with bare spots larger than six square inches; more than 15 percent of any 1,000 square feet area with bare spots larger than 4 square inches, any bare spots larger than 2 square feet.

The Contractor shall include his charge for all required grassing in the unit price proposed for furnishing and installing the pipe and in lump sum price for pump station construction as herein specified.

4.5 CONCRETE WORK

4.5.1 General

The Contractor shall perform all work necessary for or incidental to the performance and completion of concrete work. This work shall be completed as shown on the drawings and as specified in the contract documents. This work shall include the furnishing of all labor, materials and equipment. The Contractor shall be responsible for coordinating the work to assure that the work is completed in an orderly manner.

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

4.5.2 Materials

The Contractor will submit the names of suppliers of all concrete materials. Materials supplied on the project will meet the requirements of ACI 301-72, "Specifications for Structural Concrete for Buildings." Concrete will be 3,000 or 4,000 psi standard 28 day cylinder strength as shown on the plans with a maximum design slump of four (4) inches. Ready Mix Concrete must meet the requirements of ASTM C 94 "Specifications for Ready Mix Concrete." Concrete form work will meet the requirements of ACI 347 "Recommended Practice for Concrete form work." Reinforcing steel bars will be Grade 60 for bars No. 4 and larger and Grade 40 for No. 3 bars. Reinforcement bars will meet the requirements of ASTM A 615 for Billet Steel Bars.

4.5.3 Testing

Concrete testing will conform with ACI 301-72 Chapter H. Four concrete cylinders will be provided per test with two cylinders tested at seven days and two additional cylinders at twenty-eight days. One test (four cylinders) will be required per one hundred (100) cubic yards for each type concrete poured. Concrete failing the strength test will be repaired and/or replaced and re-tested at the Contractor's expense.

Concrete testing will be conducted by a laboratory selected by the Owner at the Owner's expense. The Contractor will be responsible for notifying the Owner, Engineer and testing laboratory a minimum of twenty-four (24) hours prior to placement of concrete. Concrete mix test results will be submitted to the Engineer prior to initiating concrete work showing compliance with specifications. Engineer's approval of concrete mix does not relieve the Contractor of the responsibility for the performance of the concrete.

4.5.4 Installation

Concrete will not be placed when the temperature is forty (40) degrees Fahrenheit and falling or when freezing weather is predicted with twenty-four (24) hours. The Contractor may place concrete in cold weather if approved by the Engineer and the requirements of ACI 306, "Recommended Practice for Winter Concreting" are met.

However, accelerator antifreezes and high early strength (Type III) concrete may not be utilized.

4.6 EQUIPMENT IDENTIFICATION MARKERS AND APPROVALS

4.6.1 Identification Markers

Machine-engraved, laminated plastic identification markers shall be provided on the front of the power and control panel. Unless otherwise noted elsewhere in the Contract Documents, letters shall be one-half inch and color shall be black letter on a white background. They shall be securely mounted on equipment by means of sheet metal screw, machine screws and nuts or pop rivets. Adhesive mounting will not be acceptable. These markers shall be engraved to correspond with the identification of the control items as shown on the drawings. Where Standard manufactured metal plates are available such as "Hand-Off-Automatic", etc., they shall be used but the switch shall be marked as to which pump the device indicated or controls.

4.6.2 Approval and Marking of Equipment:

Electrical devices, components and materials shall be listed and/or labeled by the Underwriters' Laboratories, Inc., and the equipment other than the control panel shall bear the UL seal.

4.6.3 Protection of Electrical Equipment

Electrical equipment shall be protected from the weather, especially from water dripping or splashing upon it, at all times during shipment, storage, and construction. Equipment shall not be stored outdoors, even if the NEMA rating of the enclosure is such that under normal operating conditions the equipment will be outside. Where equipment is installed or stored in moist areas, such as unheated buildings, etc. it shall be provided with an acceptable means to prevent condensation.

4.6.4 Defective or Damaged Equipment:

Should it be determined by the Contractor, owner, or engineer that any equipment or material has been subjected to possible damage by water, it shall be thoroughly dried and put through a dielectric test as directed by the manufacturer at the expense of the Contractor, or shall be replaced by the Contractor without additional charge.

Any equipment damaged during shipment, while stored, or during construction shall be replaced at the Contractor's expense. Minor scratches on equipment cabinets, etc., may be repaired on site. any current carrying parts, switch blades, operators, coils, contacts, etc., which are damaged, shall be replaced at no cost to the Owner or Engineer.

4.6.5 Or Equal Clause:

The use of the manufacturer's names and catalog numbers used herein is to indicate the minimum standards for quality and performance. Equipment of equal quality, rating, and performance, may be submitted for approval by the Engineer or Owner. It shall be the sole responsibility of the Contractor to prove equality and, if as a result of substitution, any modifications are necessary to meet the quality and design criteria of the specified material and/or systems, the Contractor shall be responsible for those modifications with no additional charge to the Owner or the Engineer. Any necessary modifications shall be shown on the shop drawings and submitted for approval before the equipment is released for fabrication and shipment.

4.7 ELECTRICAL SERVICE MATERIALS

4.7.1 Ground Rods and Appurtenances:

Ground rods shall be the copper clad steel type and shall be a minimum of 10 feet in length, ¾ inch in diameter. Grounded rods shall be as manufactured by Copperweld Steel Co., or equal. Grounding electrode conductors shall be bare stranded tinned copper. Equipment grounding conductor shall be copper, THW insulated, green (or green with yellow tracer) in color, and rated at 600 volts.

Ground clamps for use on iron pipes shall be galvanized or mallable iron, or of standard non-corrosive material.

Ground clamps for use on pipes shall have a rigid metal base providing good contact by proper seating on the pipe. Strap type clamps shall not be used.

4.7.2 Wiring

All conductors shall be copper, rated at 600 volts and shall be new and unused. Conductors shall be solid. AWG #8 and larger shall be stranded.

4.7.3 Conduit

Rigid conduit used on the project will be rigid, standard weight, mild steel pipe. The conduit shall receive a protective zinc coating by means of hot-dip galvanizing. Couplings, bends, elbows, fittings, etc. shall be subject to the same requirements as for the conduit. All conduit and fittings shall be UL approved. Rigid conduit shall be delivered with plastic protectors on the threads.

4.7.4 Service Poles

The service poles shall be southern pine, pressure creasote treated, roofed and gained before treatment and of the length and class as shown on the drawings. Pole hardware shall be hot dipped galvanized steel.

4.7.5 Control Cabinets

The power control cabinet shall be mounted as shown on the Drawings and the size as required to adequately contain with proper spacing circuit breakers, fuses, and all equipment and wiring shown in the control schematic. The cabinet shall be made from stainless steel, degreased and shall be finished with a rust inhibiting primer and a baked gray enamel final finish. The panel shall be constructed to the requirements of NEMA type 4 standard and shall have provisions for padlocking in the closed position.

4.7.6 Seal Fittings

Seal fittings shall be equal to Crouse-Hinds EYS of a size as required by the conduit in which the fitting is being installed.

4.7.7 Receptacles

Duplex receptacles outside the control panel shall be NEMA 5-2OR, 125 volts, 15 ampere, with high impact resistant face, brown, corrosion resistant live parts, back and side wired. Install in a cast metal type FS box with a weatherproof cover.

4.7.8 Circuit Breakers

Circuit breakers shall be sized equal to Square D QO or Q1 type, single handle for multi-pole, with interrupting capacity of at least 10,000 amperes RMS symmetrical.

4.7.9 Manual Transfer Switch

The manual transfer switch shall be sized to meet voltage, phase and current requirements of the motor and be equal to Square D, double throw safety switch, non-fusible, in a NEMA 3R enclosure, and shall be fitted with either a Grouse Hinds APQ 1047 (240 volt stations) or an Appleton AR20044 (480 Volt stations) receptacle for generator connection. Switches shall be rated as service entrance equipment.

4.8 ELECTRICAL CONTROLS

4.8.1 Magnetic Starters and Contactors:

All magnetic starters and contactors shall be steel mounted, front wired with all terminals accessible for wiring directly from the front. No slate or ebony asbestos will be permitted on any size starter. NEMA standard size shall be no smaller than 0. All contacts shall be double break, solid silver cadmium oxide alloy, or equal. Bare copper or silver flashed copper contacts which require periodic filing or cleaning maintenance will not be permitted. Contact blocks shall depend on gravity only for opening the contacts. Operating coils shall be pressure molded and so designed that, if accidentally connected to excessive voltage they will not expand, bubble, or melt. When a coil fails under any condition, the starter shall open and shall not freeze in the closed (on) position. Coils shall be rated at 120 volts and shall be replaceable from the front of the starter without having to remove the starter from the panels or enclosure.

Control circuit power shall be obtained from a control circuit transformer with fused secondary. The primary of the control transformer shall be connected across two legs of the incoming power to the starter so that opening the over current protection to the starter shall de-energize the transformer.

4.8.2 Overload Relays:

Overload relays shall be melting alloy, hand reset, trip-free variety so that blocking the reset mechanism in the reset position will not prevent the operation of the relay if the motor is overloaded. Accidentally depressing the reset button or mechanism shall not open the starter contacts. All overload relays shall be equipped with a trip indicator, visible from the front of the inside of the power and control cabinet, which will indicate which motor has tripped due to overload. Further, the starters shall each contain one (1) N.O. contact which closes when the starter is opened due to overload. Wire this contact as shown in the Control Sequence schematic. Thermal units shall be of one-piece construction and interchangeable.

NOTE:
OVERLOAD RELAYS SHALL BE INSTALLED IN ALL UNGROUNDED LEGS.

All overload relays shall be sized from actual motor name plated data taking into account the temperature ratings, starting characteristics, and current ratings of the particular motor it is protecting. Temperature ratings of the motors in relation to the overload relay ratings will be affected by the ambient temperature at the starter. These relationships shall be taken into account when sizing the overload relay thermal units following the recommendations of the particular starter manufacturer. In no case shall the relay and its thermal unit be sized higher than the percentage values given in Article 430-C of the National Electrical Code.

The starter shall be inoperative if the thermal unit is not in place. Disconnects shall be inverse time, molded case circuit breaker type. The magnetic trip shall not be adjustable to more than 1300% full load rating of the motor being protected. The interrupting rating shall be not less than 10,000 amperes, RMS, symmetrical.

4.8.3 Control Devices

Selector switch operators shall be non-illuminated, oil tight, number of positions as shown in the schematics, maintained contact, equal to Square D, Class 9001, Type "K". Where hand-off-automatic switches are shown on the drawings controlling a "Pilot" circuit of a magnetic starter, connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the "hand" position; all safety control devices such as low-or-high level cutouts, and motor overload protective devices, shall be connected in both the "hand" and "automatic" positions of the selector switch.

Contact blocks shall be gangeable, reversible, completely compatible with the necessary operator, double-break silver contacts with a flexible, movable, contact blade providing a scrubbing action with positive wipe. Contacts shall be rated at 120 volts, 10 amperes continuous and shall be equal to Square D Class 9001, Type "K".

4.8.4 Auxiliary Relays

Control relays shall be magnetic, plug-in "ice cube" type, rated 10 ampere at 240 volts, equal to Square D Class 8501, Type KP. Provide all bases mounting channel, hold downs and necessary hardware for a complete installation. Unless otherwise shown on the Drawings, coils shall be of molded construction and shall be rated to operate at 120 volts. Terminals shall be mechanical type pressure wire connectors.

Timed relay shall be the same as the control relays except equal to Square D Class 8501 type JCK. The timing device shall be solid state type. Timing range shall be shown on the drawings. Latching relays shall be equal to Square D Class 8501, Type L. Where relays are shown to require more poles than is available on a standard relay, use as many standard relays as necessary to get the required number of contacts and wire their holding coils in parallel.

Where latching relays are shown to require more poles than is available on a standard rely, use one latching relay and use one of its poles that is open in the unlatched position and closed in the latched position to control as many standard relays as necessary to get the required number of poles. Wire the standard relay holding coils in parallel.
Auxiliary relay shall be identified using the identifications shown in the schematic.

4.8.5 Legend Plates

Legend Plates shall be of the metal ring type which installs around the control device under the ring unit. Lettering shall be factory finished to denote the function of each control device.

4.8.6 Permits and Approval

The Contractor shall obtain all permits necessary.
The Contractor shall furnish inspection by an agency licensed to perform electrical inspections in the state of South Carolina. The Contractor shall notify the electrical inspector, in writing, immediately upon the start of the work and A COPY OF THE NOTICE SHALL BE SENT TO THE ENGINEER.
Inspection shall be scheduled for rough as well as finish work. The rough inspection shall be divided into as many inspections as may become necessary to cover all roughing-in.
All costs incidental to the electrical inspections shall be borne by the Contractor.
The Contractor shall furnish certificates of final approval by the electrical inspector and FINAL PAYMENT WILL BE WITHHELD UNTIL HE HAS PRESENTED THE ENGINEER WITH THE AFOREMENTIONED CERTIFICATE OF APPROVAL.

4.8.7 Reference to Other Contract Documents

The Contractor shall refer to the complete set of Contract Documents and shall base his bid on those requirements. Particular attention is called to the Instruction of Bidders and General and Special Conditions.

4.8.8 System Grounding

If not specifically sized herein, grounding conductors shall be sized in accordance with the latest edition of the National Electrical Code.
The resistance value of the main grounding conductor measured between the power and control panel and a good earth ground shall not exceed twenty-five (25) ohms.
Ground rods shall be driven vertically into the earth to at least ten feet below grade. Where rock is encountered at a depth of less than four (4) feet, rods shall be buried in a trench at not less than two feet below finished grade.

Connections to ground rods and all other ground connections below grade shall have a minimum mechanical contact surface area between the conductor and the ground rod not less than three (3) square inches.

Resistance measurements shall be made between the main grounding bar in the control panel and a good earth ground. If this resistance is not equal to or less than the value given above, an additional grounding electrode system in the form of ground rods installed and connected together in a 10 foot by 10 foot grid shall be added. The rods shall be connected together and this grid connected to the system with AWG#6 bare tinned copper. The number of rods shall be as required to register the resistance value mentioned hereinabove. Measurements shall be made in normally dry conditions and, in no case, less than 48 hours after rainfall. Where a bare conductor is the only conductor installed in conduit or other raceway, and this conductor is serving as a grounding conductor, it shall be bonded to the raceway that contains it at each end of the raceway. The bond shall be made using a grounding type busing and bonding jumper. The size of the jumper shall be the maximum size that the grounding busing lub will accept it shall be connected to the busing with the lug and to the grounding conductor with a split-bolt connector.

All metal electrical equipment cabinets shall be securely bonded to a grounding conductor running through conduit terminating at the cabinet or enclosure by use of a grounding lug busing and jumper wire to the enclosure wall.

The neutral point of all transformer secondary windings of the system shall be connected to the grounding system.

4.8.9 Installations

The poles shall be installed to a setting depth as recommended by NECA standards for the actual soil conditions present at the site. Mechanical means shall not be used in pulling in wires or cable. Approved wire pulling lubricant shall be used as required to prevent insulation damage and overstressing of the wire while pulling through conduit. in no case shall conductors be greased or coated with any substance injurious to the conductor insulation or sheath. Panel Wiring: All wiring in the panels shall be neatly wrapped, taped, or laced into groups to provide a neat and orderly appearance in the equipment. Wiring shall extend a minimum of 2 inches; thence a series of right angle bends to its respective conduit or determined point inside the panel.

Each wire or cable shall be labeled at both termination points. Individual conductor or circuit identification shall be carried throughout, with circuit number or other identification clearly stamped on terminal boards and printed on directory cards. All wire connected to terminal boards, terminal blocks, or to other similar terminals shall terminate by means of forked tongue, nylon self-insulated, tin plated copper pressure terminals as manufactured by the

Thomas & Betts Company, Inc. of Panduit Corporation. Where lugs or terminals are designed for insertion of bare wire, no pressure terminal connectors will be required. Only one wire shall be installed in each plug.

Terminal boards for control wiring shall be of the fabricated type, 600 volts, 30 amperes, screw terminal with white markings strips for wire identification; they shall be of the 4-, 6-, 8-, or 12- pole type as necessary. Terminal strips shall be clearly and permanently marked with ink or indelible pencil. Each wire shall be marked consistently throughout the entire system, using wherever possible the notation of the wires given on the manufacturer's wiring diagrams.

Rigid grade conduits, where they enter panel boards, cabinets, pull boxes or outlet boxes shall be secured in place by galvanized, double locknuts (one inside and one outside) and bushings. All bushings shall have insulating material has been permanently fastened to the fittings. Bushings for conduit one and half inches trade size and larger shall be complete with grounding lug and shall be bonded to the box by means of bare copper wire.

Bending: All field bends shall be made with standard tools and bending equipment manufactured especially for this purpose. Bends in metallic conduit shall be made while "cold" and in no case shall the conduits be heated. Conduits shall not be bent though more than 90 degrees.

4.8.10 Tests and Inspections

The Contractor shall provide all tests as specified herein and all additional tests necessary to establish the adequacy, quality, safety completed status and suitable operation of the system and components thereof. The final inspection will be made after the Engineer is satisfied that the work has been completely installed and that complete preliminary tests were made which indicated adequacy, quality, completion and satisfactory operation of the system. During the final inspection, tests shall be made to demonstrate that the entire system is in proper working order and in accordance with the Drawings and Specifications. In no case shall the tests be less than those outlined in substitution for the tests of the individual items at the manufacturer's plant. Insulation and ground resistance tests shall be made before operation tests. The costs of the tests shall be borne by the Contractor, including incident to retests occasioned by defects and failures of equipment to meet the specifications.

All wiring and equipment found defective or failing to meet the specified requirements, shall be replaced by the Contractor without charge, unless written permission for repair is given by the Engineer.

The Engineer shall be notified in advance so that he may be given the option of witnessing tests and the Contractor shall furnish four copies of all test results to the Engineer.

The Contractor shall provide suitable electrical instruments including voltmeter, ammeter, tachometer and megger.

The Contractor shall make the necessary openings in the circuits for the testing instruments and shall place and connect all instruments equipment, and devices necessary for the tests. Upon completion of the tests, the instruments and instrument connections shall be removed and all circuits shall be to their permanent condition by the Contractor.

Each completed circuit of 600 volts or less, with everything but power supply and power-consuming equipment connected thereto, shall be tested and shall have an insulation resistance between conductors and between each conductor and ground of not less than 1,000,000 ohms unless otherwise accepted by the Engineer. A megger having an output of at least 1000 volts shall be used to determine the insulation resistance value.

Test data shall list each circuit and the measured resistance. After installation, the Contractor shall megger the windings of all motors. They shall be tested in accordance with, and meet the requirements of, IEEE Standard No. 43-1974, Recommended practice for Testing Insulation Resistance of Rotating machinery. Motors shall be tested before conductors are connected and again after they have gained running temperature.

The Contractor shall test each entire grounding system for continuity of connections and for resistance. The grounding resistance of conduits, equipment cases, and supporting frames shall not vary appreciably from that of the system as a whole and shall not exceed 25 ohms.

Each motor and its associated equipment shall be operated as nearly as possible under normal operating conditions for as long as feasible and for a length of time sufficient to demonstrate correct alignment, temperature rise, speed, and satisfactory operation. The motors shall be loaded to full capacity, or as near thereto as possible. Associated equipment includes relays, circuit breakers, switches, and other devices related to the motor being tested. Where tests of any of the above referenced equipment are included in other sections of the specification, the Contractor shall coordinate the testing to avoid duplication and conflict.

All switches, circuit breakers and control devices shall be operated to show correct and satisfactory operation.

4.9 RESIDENTIAL COLLECTION STATIONS

4.9.1 General

The Contractor shall furnish all labor, material, tools and perform all work and services necessary for or incidental to the furnishing and installation, complete all operations in connection with the settling tank or residential pump station as shown on drawings and as specified in accordance with provisions of the contract documents, and completely coordinated with that of all other trades.

a. Work included in this project consists of, but is not limited to, installation of the following items:

    1. 1,000 gallon settling tank
    2. 1,000 gallon pump station including STEP package and control panel
    3. Grinder pump station and appurtenances

b. 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. This section includes the installation of the settling tank or residential pump station and all required appurtenances. The installation of the residential pump station shall include the service line from the tank to the force main. All tanks shall include a plugged 4" wye on the inlet side of the tank. Location of all tanks shall be approved by Grand Strand Water and Sewer Authority.

4.9.2 Precast Settling Tank Systems

Capacity of the settling tank shall be 1,000 gallons minimum. Either polyethylene or concrete septic tanks are acceptable. Fiberglass reinforced plastic is not considered equal as an alternate material.

All concrete settling tanks shall be manufactured by a PCI certified plant and meet ASTM C-478 or ASTM c-890 and ACI 318-83 or the latest revision. All tanks shall be built to the dimension shown on the plans and designed and certified by the manufacturer to meet H-20 loading. Design information shall be provided before any tanks are approved. All tanks shall be installed level and at the location determined by the Authority/Engineer. The settling tanks shall be watertight and free of defects upon installation.

a. Design

1. General

Design calculations shall be prepared for review and approval by the Engineer. The design shall address all aspects required to produce a watertight tank suitable for the intended purpose including, but not limited to, the following:

- o Cement Type
- o Water
- o Aggregates
- o Admixtures
- o Mix Design
- o Reinforcing
- o Form Release
- o Concrete Placement
- o Joints
- o Water Stops
- o Curing & Protection
- o Tolerances
- o Form Ties
- o Repair
- o Forms
- o Testing
- o Accessories
- o Finish

2. Minimum Requirements

b. Precast concrete septic tanks shall also meet the following minimum requirements:

1. Precast reinforced concrete walls shall have a minimum thickness of 4 inches.
2. Precast reinforced concrete tops shall have a minimum thickness of 4 inches.
3. Concrete shall have a minimum compressive strength of 5,000 psi at 28 days.

c. All tanks shall be cured by an approved method and not be shipped until:

1. The sections have attained the concrete design compressive strength.
2. The tanks have passed the specified vacuum test.
3. Seven days after fabrication and/or repair, whichever is the latter, have elapsed.

d. Self-adhering asphalt sealant strip for sealing tank joints shall be supplied by the manufacturer for all tanks.

e. The maximum water/cement ratio shall be 0.45.

3. Cements

Sulfate resistant cement shall be used conforming to the following specifications:

1. Portland cement ASTM C150, Types I, IA, II, IIA, III, IIIA, or V.
2. Portland plant furnace slag cement ASTM C595, Types IS (MS) or IS-A (MS).
3. Portland pozzolan cement ASTM C595, Type IP or IPA, except that the pozzolan content of the Portland pozzolan cement should not exceed 25% by weight.

These different cements shall not be used interchangeably in the same element or portion of the work.

4. Inlet/Outlet Connections

Inlet and outlet pipes shall be sealed watertight and shall be affixed to the structure using a flexible neoprene boot. Formed holes shall be perpendicular to the face of the tank wall and properly plugged so as to produce a smooth walled hole.

5. Reinforcing Steel

Reinforcing steel size and placement shall be determined by the design, but in any case not less than Number 4 reinforcing bars at 12-inch centers each way.

Reinforcing steel bars shall be firmly held in position, not subject to shifting upon concrete placement. There shall be a minimum distance of 1 inch from center of reinforcement to face.

Concrete shall be compacted by vibration. Vibrators may be internal, external, or surface types.

Vibrators shall have operating frequencies that produce well-consolidated placements.

b. Quality Assurance

1. Concrete Test Cylinders

Testing of concrete strengths by means of test cylinders is a critical part of the quality control program. Concrete shall be sampled and cylinders made in accordance with the following specifications:

a) ASTM C31 - Specification for making and curing concrete test specimens in the field.
b) ASTM C172 - Specification for sampling fresh concrete.
c) ASTM C192 - Specification for making and curing concrete test specimens in the laboratory.

A minimum of four test cylinders per day shall be made to indicate 7-day and 28-day test strength, or strength at an earlier age, to verify handling strength.

c. Submittals

All concrete tank manufacturers shall submit the following information:

1. A structural analysis and design calculations showing that the allowable stresses will not be exceeded during manufacture, handling, shipping, installation, testing and service.
2. Daily results of concrete test cylinders.
3. Cement and reinforcing mill reports shall be available for review if requested.

Pre-cast tanks for STEP systems shall be provided with a groove suitable for joining a reinforced concrete or fiberglass riser pipe to the top of the tank wall. The groove shall be concentric with the inlet access manhole openings on the Drawings.

Self-adhering asphalt sealant strip for sealing tank joints shall be supplied by the manufacturer for all tanks and installed in all tanks. Fiberglass access covers for STEP systems shall have the dimensions indicated on the Drawings and shall be pre-approved by the Authority. All hardware shall be stainless steel. Inlet and outlet pipes shall be affixed to the structure using a flexible neoprene boot. Formed holes shall be perpendicular to the face of the tank wall and properly plugged so as to produce a smooth walled hole. The boot shall be Kor-N-Seal Assembly as manufactured by National Pollution control Systems, Inc. of Milford, New Hampshire, or equal. The boot shall be provided in accordance with the manufacturer's specifications and as shown on the Plans.

d. Appurtenances

Settling tanks and settling tanks with pump chambers (STEP tanks) shall be supplied and delivered to the Owner's storage area with all neoprene boots installed.

All risers, upper access manhole frame and cover, float mast assembly, pump and wiring shall be supplied for a complete installation.

The quality of all materials, the process of manufacture, and the finished tanks, shall be subject to inspection and approval by the Design Engineer and the Authority. Such inspection may be made at the place of manufacture, or on the work after delivery, or at both places. Tanks shall be subject to rejection at any time on account of failure to meet any of the specification requirements; even though sample tanks may have been satisfactory at the place of manufacture. Tanks rejected after delivery shall be immediately removed from the site of the work by the Contractor at his own expense.

e. Precast Tank Finish

The Contractor shall furnish all labor, equipment and materials for the painting and shop coating of all proposed items as herein specified. All painting and coating shall be done strictly in accordance with the manufacturer's instructions and shall be performed in a manner satisfactory to the Engineer.

The exterior of all precast concrete septic tanks and precast concrete septic tanks with pump chambers shall be coated.

The paint and paint products shall be products of the Tnemac Company, Inc., Koppers Company, Inc., or equal.

Exterior concrete surfaces of the septic tanks shall be prepared by removing all dust, dirt, grease, oil, wax, and foreign matter from the surfaces and by coating with two coats of Koppers Bitumastic Super Service Black or equal prior to delivery. Film thickness shall be minimum 12 mils per coat.

Application shall be in strict compliance with the manufacturer's recommendations. Concrete shall be fully cured and dry before application.

All paint and coatings shall be applied in accordance with the manufacturer's directions. The number of coats specified is the minimum number acceptable and are intended to produce a fully covered, workmanlike, acceptable job. Additional coats are to be applied where required to obtain these results at the Contractor's expense.

On all surfaces, each coat of the paint shall be applied at the rate recommended by the manufacturer to achieve the minimum dry film thickness required. In no case shall the specified coverage rate be exceeded. Deficiencies in film thickness shall be corrected by the application of additional coats of paint.

f. Testing

All tanks delivered will be water tested and/or tested to an applied vacuum by the manufacturer.

The tank shall be evacuated through one plug using a vacuum pump to the required pressure. The Contractor shall supply three sets of plugs, fittings and coupling as necessary to close the tanks for testing.

At least one (1) plug in each set shall include piping through the plug and have connection for evacuating the tank when the plugs are in place.

The Authority reserves the right to test any or all tank(s) for water tightness at no additional cost to it.

Testing method shall be determined by the Design Engineer and may be either or both, a vacuum test or a test conducted by filling the tank with water.

The vacuum test will be performed by applying a vacuum of 4 inches of mercury for five (5) minutes. Vacuum readings will be taken at one minute intervals for five (5) minutes. Tanks that show a drop greater than 1" or do not show a stabilized pressure after (5) minutes will be considered to have failed the vacuum test.

The water test will be performed by filling the tank with water for 24 hours after all tank openings and penetrations have been plugged and sealed. Tanks shall show no leakage from section seams, pinholes, or other imperfections.

The intent of the vacuum and water tests is to ensure the Authority that structurally sound and watertight tanks are provided.

The above tests will be performed at the Contractor's storage facility after the tank has been delivered and assembled by the manufacturer.

Tanks will be rejected which do not meet the requirements specified herein when inspected by the Engineer/Authority upon delivery to the construction site. Tanks will also be rejected which fail to pass the specified vacuum test in a maximum of three (3) attempts.

g. Warranty

The Contractor shall warranty each tank or one year from date of the Authority's approval for operation.

4.9.3 Polyethylene Settling Tank System

Polyethylene settling tanks shall be rotationally molded from high density polyethylene with minimum physical properties sufficient to meet the requirements of these specifications. Raw materials shall be tested in accordance with the appropriate ASTM specifications for flexural modulus, melt index, and impact strength.

a. Design

1. Standard-Duty tanks shall withstand soil cover heights of up to 4.0 feet over the outlet invert and occasional period when the water table is within three feet of the ground surface.

2. Heavy Duty tanks shall withstand soil cover heights of up to 5.5 feet over the outlet invert and extended periods of high ground water at the ground surface.
3. Ultraviolet Light Protection: Tanks shall contain sufficient UV inhibitor for a minimum of 2 years outside storage with no significant loss of physical properties.
4. Cut Edges: All edges shall be smooth.

b. Riser

The riser cover shall be made of high density structural foam polyethylene. The cover shall rest on the outside of the riser, and the lip extended across the riser. Stainless steel self-tapping screws shall be provided to fasten down the lid and to prevent tampering. Backfill should always be placed even with the top of this lip. The backfill soil will help prevent odors by filtering the gases exiting from underneath the manhole cover.

The riser shall access to the tank from the ground surface. It shall be corrugated to provide strength against horizontal compression. One end is flared to fit over the tank manhole; the other end will not fit. The riser shall be attached to the tank with 20 stainless steel screws and washers spaced uniformly around the tank manhole. "ConSeal" sealant or approved equal shall be placed between the riser flange and the tank to provide a watertight seal.

c. Quality Assurance

1. Identification: Each tank shall have a serial number permanently branded into it at two locations: (1) directly above the inlet, and (2) in the manhole area so it is visible after installation whenever the manhole cover is removed. This serial number shall cross-reference raw material physical properties and manufacturing records. A warranty card shall be sent with each tank with the serial number of the tank clearly marked on the warranty card.
2. Test for watertight integrity: The Authority reserves the right-to-water test any tank for water tightness. Tests may be performed at the manufacturer's production site, at time of delivery, or upon installation prior to final back filling. The intent of the test is to ensure watertight septic tanks under high groundwater conditions.
   The water test will be performed by filling the tank and attached riser with water to a height of 2 feet above the riser-to-tank connection. Any leakage within 24 hours constitutes failure of this test.
3. Test for Structural Integrity: The Authority reserves the right to vacuum test any tank.

   The vacuum test will be performed prior to installation of the riser. The test will consist of placing airtight plugs in the inlet, outlet, and manhole openings, and then subjecting the tank to a vacuum equal to four inches of mercury. Measurements shall be taken of the height, width, and length of the tank.

Changes in either the height, width, or length of the tank by more than two inches at the end of five minutes and while the tank is still under vacuum constitutes structural failure and is cause for rejection. Leakage test criteria shall in accordance with Paragraph 4.9.2.F.

4. The tank shall be designed to resist flotation under conditions of the water table at the ground surface, one foot of soil cover, and no liquid in the tank. Design calculations shall be submitted which support the anti-flotation characteristics of the tank under these conditions.

d. Warranty

The Contractor shall warrant to the Authority each complete tank installation for defects in materials and workmanship for a period of one year from the date the Authority approves the Settling Tank/STEP system for operation.

The tank manufacturer shall warrant their tanks to remain watertight and structurally sound for a period of three (3) years from date of manufacturer, and for at least two (2) years after delivery to the job site. This warranty includes any joints and fittings installed by the manufacturer.

The manufacturer warranty shall not relieve the contractor of any obligations under his warranty to the Authority.

e. Submittals

1. Required Submittal Information: All submittals shall contain the following information:

   a) Data sheets, drawings, and detailed specifications which prove conformance with the requirements of these specifications.
   b) Warranty: The tank manufacturer's warranty that their tanks shall remain watertight and structurally sound for a period of three years from date of manufacture, and for at least two years after delivery to the job site. This warranty to include any joints and fittings installed by the manufacturer, and others installed according to the manufacturer's recommendations.
   c) Installation Requirements: Copies of the recommended methods of installation and standard operating procedures.
   d) Other specific information as required for polyethylene tanks.

The quality of all materials, the process of manufacture, and the finished tanks, shall be subject to inspection and approval by the Design Engineer and the Authority. Such inspection may be made at the place of manufacture, or on the work after delivery, or at both places. Tanks shall be subject to rejection at any time on account of failure to meet any of the specification requirements; even though sample tanks may have been satisfactory at the place of manufacture. Tanks rejected after delivery shall be immediately removed from the site of the work by the Contractor at his own expense.

4.9.4 Construction Procedures for Polyethylene Tank

a. Excavation

Side wall clearance shall be a minimum dimension of 6". Bedding shall be a minimum dimension of 4". Cover shall be a minimum of 12" and a maximum of 48". All OSHA regulations regarding proper excavation procedures must be followed.

b. Bedding

Bedding shall be of select aggregate or some other material approved by the Authority and the Project Engineer. The bedding must conform to the bottom of the tank and reach a compaction of 85% Standard Proctor Density. Should wet conditions be encountered during installation, the excavated hole shall be dewatered to allow proper placement of bedding and backfill material. In no case should the septic tank be forcibly placed in the bottom of the excavated hole.

c. Tank Placement

Lifting of tank for placement shall be in accordance with manufacturer's recommendation. Do not lift the tank by the inlet or outlet hardware.

d. Initial Backfill

Select aggregate shall be placed in uniform layers around the tank. This can be easily accomplished by temporarily placing the manhole cover over the top of the tank and dumping the select aggregate directly over the manhole cover. Care should be taken to ensure that the select aggregate flows evenly underneath the haunches of the tank. The select aggregate should be placed to a height of 4" above the spring line (mid-height level) of the tank. Check the tank for the proper level and alignment.

e. Inlet/Outlet Connection

1. Refer to the project plans regarding the complete installation detail for inlet/outlet connections.
2. Standard Production Inlet: Inlet plumbing accepts schedule 40 pipe as a gasketed watertight connection. All connecting pipe should be pushed into the bell end or the tank until the pipe is firmly seated (approximately 2").
3. Settling Tank Outlet: The outlet plumbing also accepts schedule 40 pipe as a gasketed watertight connection and should be installed the same as the inlet connection.

4. STEP Tank Outlet: A factory installed neoprene grommet is provided in the tank wall opposite the inlet which accepts 1-1/2" PVC schedule 40 pipe or 1-1/2" polyethylene pressure pipe based on the controlled outside diameter, as designated by standard specification ASTM D3035.
5. All bridging distances should be kept to a minimum, although the sidewall clearance should be maintained.

f. Filling With Water

After the initial backfill, the tank should be filled with water to at least the midpoint level of the tank.

g. Final Backfill

During final back filling, care should be taken to avoid disturbing the level of the tank. Native soil can be used for final backfill, but again, should be placed in uniform layers around the tank. Remove all stones larger than 3" from this final backfill.

Select aggregate should be used under the inlet and outlet piping for optimum support. An alternative to the use of select aggregate would be to tamp the native soil underneath the inlet and outlet connection to at least 90% standard proctor density in a 6" zone immediately adjacent to the riser to prevent vertical compression as the backfill soil consolidates. An alternative would be to place select aggregate material a minimum distance of 6" around the riser. Mound the backfill soil above grade in anticipation of natural settling.

4.9.5 STEP Pumps and Related Appurtenances

Furnish and install one submersible pump in the residential pump (STEP) station as indicated on the drawings. Pump shall be rated 1 HP, 230 volt, single phase, providing 40 gpm at 50' total dynamic head. Pumps shall be Myers model WP 102, Zoeller or approved equal.

Motors shall be oil-filled with constant bearing lubrication, and be permanent split capacitor type with no starting switch to fail. The housing shall be cast iron with pressed in stator for best heat transfer and alignment.

The impeller shall be of the recessed vortex bronze design, with an unobstructed passage in the volute case which allows the passage of stringy trash and slurries without plugging the impeller. Pump shall be designed to pass a ¾ inch diameter solid.

Pump shall have a mechanical seal constructed of carbon and ceramic.

a. Level Controls

Pump on and off levels, and high water alarm shall be controlled by low voltage mercury float switches.

Mercury switches shall be sealed in solid polyurethane float ball.

Float switches shall be mounted on a stainless steel bracket so that they can be cleaned or replaced without disturbing pump or piping.

b. Discharge Package – Service Lateral

Quick release discharge piping with 1-1/2" PVC/plastic ball valve:

A 1-1/2" plastic ball check valve shall be installed in a vertical position within the tank. A redundant 1-1/2" ball check valve shall be placed at the service saddle connection to the main. Flomataic or approved equal.

Installation shall include a 1-1/2" Schedule 40 PVC and fittings from pump to force main including tapping saddle, 1-1/2" corporation stop or teflon coated ball valve when a tee is used, and redundant 1-1/2" ball check valve. Installation price shall include boring service under road for paved highways.

Equipment installation shall be per standard plan and detail as approved for Step Tanks.

All piping, PVC True Union valves and appurtenances shall be per standard details provided for this application.

1/2" Dacron rope shall be provided for lifting pump.

c. Control Panel (STEP systems)

1. All control elements shall be mounted in a NEMA 4X fiberglass enclosure with locking hasps. The voltage shall be 230 volt and a transformer shall be supplied to reduce line voltage to 24 volts for control circuit. The panel shall be as manufactured by American Manufacturing Company or approved equal.
2. A 2 pole main circuit breaker for the pump, and a separate breaker for the alarm and control circuits shall be provided. Breaker size shall be in accordance with NEC specifications.
3. There shall be a separate locatable waterproof main disconnect between the meter base and the pump control panel.
4. The high water alarm shall consist of a flashing red light with a long life bulb, and a NEMA 4 Son Alert that emits 89 DB at 10 feet. This alarm is to be activated by controls as previously specified. A weatherproof push to silence button for bell/buzzer shall be mounted on side of cabinet and labeled accordingly.
5. Hand-Off-Auto (HOA) switch, run time hour meter alarm test-off-auto switch and amber run light shall be mounted on partial sub panel inside door.
6. All push-buttons, selector switches, lights, wiring etc. shall be shown on a schematic that is mounted on inside of enclosure door.

7. The control panel shall be installed at a location in accordance with plans approved by the Authority.

d. Instructions

1. Complete instructions covering all wiring diagrams trouble shooting data shall be included with each control box, and complete servicing and installation instructions for pumps shall be included with each pump.
2. The Contractor shall obtain all permits and arrange all inspections necessary for the installation of his work, furnishing the Engineer with certificates of inspection from all authorities having jurisdiction. For additional information, refer to Sections 4.6 through 4.8.

4.9.6 Residential Grinder Pump Stations

a. Instructions

1. The Residenital Grinder Pump Station(s) shall be complete factory built and tested, each consisting of a grinder pump suitably mounted in a fiberglass basin, pump removal system, shut-off valve, anti-siphon valve, and check valve assembled within the basin, remote electrical alarm/disconnect panel, and all necessary wiring and controls. The pump(s) shall be a semi-positive displacement type grinder unit Environmental One or approved equal.
2. Work under this Section includes supplying and delivering grinder pump stations and ancillary equipment and performing field testing after installation as described herein.
3. At the time of delivery, the Authority will inspect the equipment. Any defects determined by the Authority shall be cause for rejection.

b. Warranty

The Grinder Pump station(s), including alarm/disconnect panel, shall be warranted from any defect in material and/or factory workmanship for a period of twenty-four (24) months from date of installation or twenty-seven (27) months from date of shipment, which ever occurs first, provided the product is installed, serviced, and operated under normal conditions according to the manufacturer's instructions. Repair or parts replacement required as a result of such defect will be made free of charge during this period upon return of the defective parts or equipment to the manufacturer or its nearest authorized service center.

c. Products

1. Pump Stations

a) The pump station manufacturer shall provide the factory-built Grinder Pump Stations, each consisting of a grinder pump(s), suitably mounted in a fiberglass

basin, pump removal system, remote electrical control panel, and all necessary internal wiring and controls.

b) The pump(s) shall be either a semi-displacement type or a submersible end suction centrifugal grinder type.

2. Operating Conditions

The pump(s) shall be capable of delivering 11 GPM against a normal rated total dynamic head of 92 feet. At zero head, minimum output shall be 15 GPM minimum. The pump(s) shall be capable of up to 138 feet of total dynamic head with a minimum flow of 8 GPM. The electrical rating of each pump shall be 1 phase, 240 volt, 60 hertz. Pumps shall be Environmental One or approved equal.

3. Fiberglass Tank

The tank shall be custom molded of fiberglass reinforced polyester resin and shall have a nominal wall thickness of 3/16" and a minimum net capacity of 60 gallons. The tank shall be furnished with one PVC closet flange to accept 4" nominal diameter PVC Drain-Waste-Vent (DWV) pipe using the solvent-weld system. The socket fittings shall be securely fastened to the tank and shall be leak tight.

4. Semi-Positive Displacement Pump

a) Grinder Pump

The pump shall be a custom designed, integral, vertical rotor, motor driven, solids handling pump of cavity type with mechanical seal. The rotor shall be thoroughly hardened, highly polished, precipitation hardened stainless steel. The stator shall be of a specially compounded ethylene propylene synthetic elastomer. The material shall be suitable for domestic wastewater service. Its physical properties shall include high tear and abrasion resistance, temperature stability, good aging properties, and outstanding wear resistance. Pumps shall be Environmental One or approved equal.

b) Grinder

The grinder shall be positioned immediately below the volute passage and shall be direct-driven by a single, one-piece motor shaft. The grinder impeller assembly shall be securely fastened to the pump motor shaft. The grinder will be of the rotating type with a stationary hardened and ground chrome steel shredding ring spaced in accurate close annual alignment of the driven impeller assembly, which shall carry two hardened type 400 series stainless steel cutter bars. This assembly shall be balanced and operate without objectionable noise or vibration over the entire range of recommended operating pressures.

The grinder shall be constructed so as to eliminate clogging and jamming under all normal operating conditions including starting. Sufficient vortex action shall

be created to scour tank free of deposits or sludge banks which would impair the operation of the pump. These requirements shall be accomplished by the following, in conjunction with the pump:

1. The grinder shall be positioned in such a way that solids are fed in an upward flow direction.
2. The inlet shroud shall have a diameter no less than 5 inches.
3. At maximum flow the average inlet velocity must not exceed 0.2 feet per second.
4. The impeller mechanism must rotate at a nominal speed of no greater than 1800 rpm.

The grinder shall be capable of reducing all components in normal domestic sewage, including a reasonable amount of "foreign objects", such as paper, wood, plastic, glass, rubber and the like, to finely-divided particles which will pass freely through the passages of the pump and the 1 ¼" diameter discharge piping.

c) Electric Motor

As a minimum, the motor shall be a 1 H.P., 1725 RPM, 240 volt, 60 hertz, 1 phase, capacitor start, ball bearing, squirrel cage induction type with a low starting current not to exceed 30 amperes and high starting torque of 8.4 foot pounds.

Inherent protection against running overloads or locked rotor conditions for the pump motor shall be provided by the use of an automatic reset, integral thermal overload protector incorporated into the motor. The thermal overload protector shall reset automatically when the motor cools. Motor thermal overload protector shall be approved by Underwriters' Laboratories.

Control Panel shall be in accordance with Section 4.9.

A 2 pole main circuit breaker for the pump and a separate breaker for the alarm and control circuits shall be provided. Breaker size shall comply with NEC specifications.

d) Mechanical Seal

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

e) Integral Access Way

The access way shall be an integral extension of the FRP tank and shall be custom molded of fiberglass reinforced polyester resin and shall have a minimum wall thickness of 3/16th and a minimum burial of 5.5 feet. It shall have an access

opening at the top to accept a lockable fiberglass cover with skirt. The access way shall include the following factory installed items: Copper 1 ¼" grinder pump discharge extension with a surface operable positive sealing quick disconnect coupling and a full ported shut-off valve terminating in a watertight bulkhead fitting with external 1 ¼" male pipe thread, and a 2" PVC internal vent for venting the tank. Internal wiring shall terminate in a sealed junction box, integral with the access way and suitable for outdoor use.

f) Core Unit

The Grinder Pump shall have cartridge type easily removable core assemblies containing pump, motor, grinder, controls, check valve, anti-siphon valve and wiring.

The water tight integrity of the core unit, including wiring and access cover, shall be established by 100% factory rest at a minimum of 5 psig.

g) Anti-Siphon Valve

The pump shall be constructed with a positively-primed flooded suction configuration. As added assurance that the pump cannot lose prime even under negative pressure conditions in the discharge piping system, the pump shall be equipped with an integral anti-siphoning, air relief valve in the discharge piping just below the main check valve. The valve will automatically close when the pump is running and open to atmosphere when the pump is off.

h) Check Valve

Each grinder pump station shall have one separate check valve for installation in the 2" service lateral at the sewer main. The valve shall be a 2" ball check valve. This valve will provide a full-ported passageway when open, and shall introduce a friction loss of less than 6 inches of water at maximum rated flow. See standard detail drawing for check valve application.

i) Discharge Package – Service Lateral

A ball check valve shall be placed at the service saddle connection to the main. Flomataic or approved equal.

Installation shall include SDR-9 HDPE or PEXa and fittings from pump to force main including tapping saddle, 2" corporation stop, or telfon coated ball valve when a tee is used, and redundant 2" ball check valve. Installation price shall include boring service under road for paved highways.

Equipment installation shall be per standard plan and detail as approved for Grinder Tanks.

All piping, PVC True Union valves and appurtenances shall be per standard details provided for this application.

½" Dacron rope or galvanized chain shall be provided for lifting pump.

j) Controls

Necessary controls shall be integral with the grinder pump and shall be located in the top housing of the core unit inside a waterproof access cover. The cover will be attached with stainless steel, tamper-proof fasteners. Non-fouling wastewater level detection for controlling pump operation shall be accomplished by monitoring the pressure changes in an integral air-bell level sensor connected through airtight tubing to a pressure switch. The level detection device shall have no moving parts in direct contact with the wastewater. High-level sensing will be accomplished in the manner detailed above by a separate air-bell sensor and pressure switch of the same type.

Each level control shall have its own built-in fail safe design which will prevent the entrance of moisture into the controls in case of switch diaphragm failure. To assure reliable operation of the pressure sensitive switches, each core shall be equipped with a quick disconnect breather assembly, complete with a check valve to prevent accidental entry of water into the motor compartment in the event of access way flooding.

The grinder pump will be furnished with two ten foot (10') lengths of type UF cable, pre-wired and connected with weatherproof materials. The power supply cable shall be 12-2 w/ground, designed for single phase, 240 volt, 60 Hertz power supply, and meet UL requirements. The signal cable to a high level indicator alarm device shall be 14-2 w/ground, designed for a single phase, 120 volt, 60 Hertz power supply and meet UL requirements.

Grinder station radio telemetry equipment shall be installed on all grinder lift stations serving more than one building or more than one customer.

k) Serviceability

The grinder pump core unit shall have two lifting eyes provided in the top housing, all mechanical and electrical connections must provide easy disconnect accessibility for core unit removal and installation. All maintenance tasks for the grinder pump station must be possible without direct entry of the grinder pump station.

l) Control Panel

Control panel shall comply with Section 4.9 and be per adopted standard drawing details.

m) Corrosion Protection

All materials exposed to wastewater shall have inherent corrosion protection: i.e., cast iron, fiberglass, stainless steel, PVC.

n) Wiring

It shall be the responsibility of the electrical contractor to furnish and install, service entrance equipment and/or branch circuit protection and all wiring to the grinder pump leads, in compliance with the appropriate national and local codes.

o) Safety

The Grinder Pump shall be free from electrical and fire hazards as required in a residential environment. As evidence of compliance with this requirement, the completely assembled and wired Grinder Pump Station in its tank shall be listed by Underwriters Laboratories, Inc. to be safe and appropriate for the intended use.

5. Execution

a) Factory Test

Each grinder pump shall be submerged and operated for 5 minutes (minimum). Included in this procedure will be the testing of all ancillary components such as the anti-siphon valve, check valve, discharge piping, level sensors, each unit's dedicated controls, etc. All factory tests shall incorporate each of the above listed items. Actual appurtenances and motor controls which will be installed in the field shall be particular to the tested pump only, a common set of appurtenances and motor controls for all pumps will not be acceptable. Certified test results shall be supplied showing the operation of each grinder pump at three (3) different points on its curve, with the maximum pressure no less than 60 psi. The Authority reserves the right to inspect such testing procedures with representatives of the owner, at the grinder pump manufacturer's facility.

b) Delivery

All Grinder Pump units will be delivered to the job site, 100% completely assembled, including testing, ready for installation. Each grinder pump unit will have a minimum of four (4) lifting eyes to facilitate unloading and be individually mounted on wooden pallets.

c) Installation

Contractor shall be responsible for handling ground water to provide a firm, dry sub-grade for the structure, and shall guard against flotation or other damage resulting from general water or flooding. The grinder pump units shall not be set into the excavation until the installation procedures and excavation have been approved by the engineer.

A 6" (minimum) layer of naturally rounded aggregate, clean and free flowing, with particle size of not less than 1/8" or more than ¾" shall be used as bedding material under each unit. A concrete anti-flotation collar, as detailed on the contract drawings, and sized according to manufacturer's instructions, shall be secured to the pump tank.

The contractor will provide and install a four (4) foot piece of four or six inch (as specified on contract drawings) Schedule 40 PVC pipe with cap, to stub-out the inlet for connection by the property owner.

Backfill shall be sand, loam, a suitable imported material and/or clean native earth, free of rocks, roots, organic matter, and foreign objects shall be thoroughly compacted in lifts not exceeding 12" to final Proctor Density of not less than 85%. The grinder pump shall be installed at a minimum depth as specified from grade to the top of the 1 ¼" discharge line. The finish grade line shall be 6" below the top of the access way, and final grade shall slope away from the grinder unit.

All restoration will be the responsibility of the contractor. Per unit costs for this item shall be included in the contractors' bid price for the individual grinder pump units. The properties shall be restored to their original condition in all respects, including, but not limited to, curb and sidewalk replacement, landscaping, loaming and seeding, and restoration of the traveled ways as directed by the Authority.

d) Start-up

The contractor shall provide start-up and field testing services prior to acceptance by the owner. All equipment and materials necessary to perform testing shall be the responsibility of the contractor. This will include, as a minimum, a portable generator (if temporary power is required), ammeter, and water.

The services of a trained factory-authorized technician shall be provided by the manufacturer at a rate of one (1)-four (4) day week for each 100 grinder pump stations supplied. Each day shall be ten (10) man hours in duration.

Upon completion of the installation, the contractor will perform the following test on each station in the presence of the engineer and an Authority representative:

1. Make certain the discharge shut-off valve is fully open. This valve must not be closed when the pump is operating. In some installations, there may be a valve(s) at the street main that must also be open.
2. Turn on the alarm power circuit.
3. Fill the wet well with water to a depth sufficient to verify the high level alarm is operating. Shut off water.
4. Turn on pump power circuit. Initiate pump operation to verify automatic "on/off" controls are operative. Pump should immediately turn on. Within one (1) minute alarm light will turn off. Within three (3) minutes the pump will turn off.
5. Observe amperage readings to verify proper electrical conditions are met.

e) Tank Installation

Excavate a hole to a depth, so that 6" of the access way extends above the finished grade line, the grade should slope away from the unit. The diameter of the hole must be large enough to allow for a concrete anti-floatation collar to be placed under the unit. Place the anti-floatation collar on a 6" bed of gravel, naturally rounded aggregate, clean and free-flowing, with particle size not less than 1/8" or more than ¾" in diameter. The concrete anti-floatation collar is required to keep the unit from floating due to high ground water levels. The anti-floatation collar shall be appropriately sized for the type pump station to be installed.

f) Backfill

Final backfill around the tank shall be clean native earth, free of rocks, roots, organic matter and foreign objects. The fill should be compacted in lifts not to exceed one foot to a final Proctor Density of not less than 85%.

6. Submersible Centrifugal Pump

a) Pump

The pump shall be a custom designed, vertical suction, motor driven, solids handling pump with mechanical seal. The impeller shall be of 85-5-5-5 bronze, recessed type. Shaft seals shall be ceramic and carbon.

b) Grinder

The grinder shall be positioned immediately below the pumping elements and shall be direct-driven by a single, one-piece motor shaft. The grinder impeller assembly shall be securely fastened to the pump motor shaft. The grinder will be of the rotating type with a stationary hardened to 58-60 Rockwell C with 440 C stainless steel shredding ring.

Grinder shall be constructed so as to eliminate clogging and jamming under all normal operating conditions including starting. Sufficient vortex action shall be created to scour tank free of deposits or sludge bands which would impair the operation of the pump.

The grinder shall be capable of reducing all components in normal domestic sewage, including a reasonable amount of "foreign objects" such as paper, wood plastic, glass, rubber and the like, to finely-divided particles which will pass freely through the passages of the pump and the 1-1/2" diameter discharge piping.

c) Electric Motor
The motor shall be as specified HP, 3450 RPM, 230 volt, 60 Hertz, single phase, submersible.

The motor shall operate submerged and shall be housed in oil filled, water-tight casing. The motor shall have permanently lubricated, anti-friction bearings and stainless steel shaft, and continuously run submerged and un-submerged without exceeding temperature limits. Thermal overload protection must be provided.

Grinder pumps and motors shall be listed by U.L. or meet NEC requirements for Class 1, Division 1, Group D service for such locations. Guaranteed submergence shall not be considered equal to the U.L. listing for the application or Class 1 Division 1, Group D listing required.

d) Mechanical Seal
Submersible motors shall be equipped with double shaft seals to prevent leakage between the motor and pump. A seal failure detector to sense moisture in seal cavity must be supplied with alarm and lockout capability.

e) Rail System
Each basin shall be equipped with a rail system and ***stainless steel cable*** to allow easy removal of the pump(s) from the top.

f) Check Valve
The pump shall be equipped with a 1-1/2" PVC ball check valve mounted in a vertical position. The valve body shall be a high glass injection molded part made of PVC type 1-11, Flo Matic or approved equal.

7. Controls

a. Electrical control box duplex single phase shall be manufactured by F.E. Myers Co. or approved equal. All control elements shall be mounted in NEMA 4 x enclosure.

b. Single phase power shall be 230 volts and a transformer shall be furnished to reduce line voltage to 24 volts for control circuit.

c. NEMA 4X enclosure shall have a separate inside hinged sub-door to provide for mounting control switches, lights and overload reset buttons. Outer door on the NEMA 4 x enclosure shall have a hasp for padlock.

d. A 2 pole main circuit breaker for each pump shall be mounted with the operating handles through the door and shall have a lock arrangement that prevents the door from being opened when breakers are in the "on" position. When breakers are "off" all power shall be killed to the control elements.

e. There shall be a separate lockable water proof main disconnect between the meter base and the pump control panel.

f. Start and run capacitors and start relays for each pump shall be mounted in the control box.

g. A magnetic contactor shall be provided for starting each motor and manual reset Klixon overload shall be provided to protect each pump against excessive over current condition.

h. A heat sensor thermostat in motor shall be wired in series with the magnetic contractor coils to protect the motor against excessive heat. Thermostat shall reset automatically when motor cools. A seal leak probe installed in each motor shall be connected to red signal lights on control box door.

i. An alternator relay shall be supplied to alternate pumps on each successive cycle and an override relay shall be used to start both pumps if inflow is greater than one pump can handle and shall start the second pump in case operating pump fails. The override relay shall also actuate the alarm.

j. A power transfer relay shall be supplied to transfer power to control circuit transformer in case a circuit breaker trips.

k. H-O-A switches, alarm switch, run lights, seal leak lights and overload reset buttons shall be mounted on the sub-door.

l. A terminal strip with box type connectors shall be supplied to make all power and control connections for both pumps. All terminals shall be marked for easy identification. A ground terminal strip shall also be provided.

m. A high water alarm buzzer and a flashing red alarm light shall be mounted on outside of NEMA 4X enclosure. The alarm to be actuated by controls as previously specified.

8. Corrosion Protection

All materials exposed to wastewater shall have inherent corrosion protection: i.e., cast iron, fiberglass, stainless steel, PVC. Any exterior steel surfaces are to be suitably protected against corrosion.

9. Safety

The grinder pump shall be free from electrical and fire hazards as required in a residential environment. As evidence of compliance with this requirement, the completely assembled and wired grinder pump in its tank shall be listed by Underwriters' Laboratories, Inc., to be safe and appropriate for use intended (residential grinder pump service). In absence of such U.L. listing, the grinder pump equipment as a minimum must meet NEC requirements for Class 1, Division 1, Group D, explosion proof service for such locations.

10. Certified Pump Performance Testing

Each pump shall be tested at the factory and certified by the manufacturer as to flow and head output. Copies of the test results for each pump shall be furnished with the pump.

4.9.7 EXECUTION

a. The grinder pump manufacturer shall provide the services of qualified factory trained technical serviceman who shall inspect the placement and wiring of each station, perform field tests as specified herein, and instruct the Authority's personnel in the operation and maintenance of the equipment before the stations are accepted by the Authority.

b. All equipment and materials necessary to perform the testing shall be the responsibility of the grinder pump station manufacturer. This will include, but not be limited to as a minimum, a portable generator, amp meter, and water. Water will be furnished by the Authority.

c. After the pump stations have been set and wired, the grinder pump manufacturer or contractor shall perform the following test procedure on each station:

1. Fill the wet well with water to a depth sufficient to verify the high water alarm is operative.
2. Initiate pump operation to verify all controls are operative.
3. Observe amperage readings to verify proper electrical conditions are met.

4.9.8 Instructions

a. Complete instructions covering all wiring diagrams and trouble shooting data shall be included with each control box, and complete servicing and installation instructions for pumps shall be included with each pump and provided to the Authority by the Contractor.

b. The Contractor shall obtain all permits and arrange all inspections necessary for the installation of his work, furnishing the Engineer with certificates of inspection from all authorities having jurisdiction.

c. Contractor shall provide spare pumps, floats, and control panels in the amount of 5% of the total project count of pump station installations (as applicable).

d. The installation instructions herein do not supersede any standard installation and safety requirements as required by the Occupational Safety and Health Administration (OSHA) or other governing bodies.

4.10 EFFLUENT PUMP STATIONS AND APPURTENANCES

4.10.1 Motor

Pump motor shall be of the submersible type rated at the designated horsepower. Motor shall operate at 3450 RPM and shall be for 208 or 230 volts single phase or capacitor type with no relays or starting switches. Stator winding shall be of the open type with Class A (105 degrees C) insulation for operating in clean dielectric oil that lubricates bearings and seals and cools the winding.

Stator shall be pressed into housing for the best alignment and heat transfer.

Common motor pump shaft shall be supported by a lower ball bearing to take thrust and radial loads and by an upper bronze sleeve bearing or ball bearing to take radial load only.

Single phase motors shall have an overload element embedded in the winding to protect the motor against over current and overheating conditions. Overload element shall automatically reset when motor cools.

The motor is to be a completely assembled unit with end plate for mounting in volute case. Complete motor and pump impeller to be removable as a unit from the volute casing.

4.10.2 Corrosion Protection

All iron castings shall be pre-treated with phosphate and chromic rinse and shall be painted with high temperature bake epoxy before machining and all machined surfaces exposed to

sewage water to be re-painted with high temperature bake epoxy. All fasteners to be 302 stainless steel.

4.10.3 Shaft Seals

Motor shall be protected by two mechanical seals mounted in tandem with a seal chamber between the seals. Seal chamber shall be oil filled to lubricate seal face and to transmit heat from shaft to outer shell. Seal face shall be carbon and ceramic and lapped to a flatness of one light band.

Where specified, an electrode shall be mounted in the seal chamber to detect any water entering the chamber through the lower seal. Water in the chamber shall cause a red light to turn on at the control box. This signal shall not stop the motor, but shall act as a warning only, indicting service is required.

4.10.4 Impeller

Shall be bronze and of the recess type. Pump-out vane shall be used on back shroud. Impeller shall be dynamically balanced by grinding on back shroud. No holes to be drilled to balance. The impeller is to be threaded on shaft and held in position with lock nut.

Impeller and motor shall have top lift-out of case so that the assembly can be removed without disturbing any piping.

4.10.5 Pump Case

The volute case shall be of cast iron and shall be provided with bolt-on flange so the 2" or 3" pipe size may be used.

4.10.6 Power Cord Seal

The power cord shall be potted into a seal connector with polyurethane resin for leak-proof seal. A cord nut and rubber grommet shall clamp the cord into the bushing. Cords shall withstand a pull of 100 pounds. The power cord shall be one piece from motor to control panel. No splice connections will be allowed.
The motor control panel, power control panel and other electrical panels shall be mounted above the 100 year flood elevation.

4.10.7 Site Layout

Wet well (minimum 5' diameter) and above ground appurtenances shall be located in such a manner as to provide an adequate unobstructed area within fence for placement of emergency generator or bypass pumps.

4.10.8 Approved Pumps

Acceptable pump manufacturers for submersible effluent pumps are Flygt, ABS, Myers, or approved equal.

4.10.9 Pump Design Specifications

a. Each pump shall be designed to handle peak flow.
b. Motors shall be non-overloading over entire pumping range.
c. Motors shall have Class F (155 deg. C) insulation and withstand Class B (130 deg. C) temperature rise with a service factor of 1.0 at the efficient point of the curve.
d. Unbalanced voltage on motors under load shall not exceed 1.0% when measured at the motor terminals. Voltage shall be read with an accurate digital volt meter; and recorded as part of the final inspection; calculations shall be NEMA Standard G1-1972 (See Vol.1a-11, No. 1, Jan/Feb 1974 IEE Transaction Industrial Application).
e. Lightning arresters are required for all services.
f. Pump(s) and motor(s) shall have adequately sized ***stainless steel lifting cable(s);*** length shall reach top of station plus an additional six feet.
g. All piping shall be thickness class D.I.P. cement lined and all fittings shall be ductile iron rated at a working pressure of 250 psi. All pipe shall be American Cast Iron Pipe Company or equal. All valves shall be eccentric plug valves with open left valve stem operation.
h. Motor shall be equipped with overheat sensor and shall shut down the motor. Control panel shall have separate indicator lamp for overheat shutdown.
i. Motor shall be wired for lead-lag operation and shall be equipped for alternate cycle operation.
j. Each motor shall have a separate run time totalizer and HOA switch.
k. The flange adapter within the pump station wet well shall be the 2100 MegaFlange® Restrained Flange adapter as produced by EBAA Iron, Inc. or approved equivalent.

*See other sections for further specific requirements and standard drawings for a complete effluent pump station installation.

4.11 DUPLEX GRINDER PUMP STATIONS

A. Duplex Grinder Pump Station may be utilized for commercial or residential developments consisting of 100 residential equivalent units or less. Acceptable pump manufacturers for grinder pumps are Flygt, Myers, ABS or approved equal.
B. Grinder Pumps shall have the following:
    1. Four foot minimum diameter concrete wet well, unless otherwise approved by GSWSA.

2. Liquid level controls. Four floats and submersible pressure transducer connecting to telemetry.
3. Control panel shall have telemetry equipment
4. Double guide rail system
5. Fall protection, see Section 4.2.15.

C. All duplex grinder pump stations shall have 2" stainless steel discharge piping and 2" stainless steel pumper connection.

D. All fittings shall be American Cast Iron Pipe Company, Tyler Union, Sigma or approved equal. All valves shall be eccentric plug valves with open left valve system and no quarter turn, unless otherwise approved by GSWSA.

E. Three (3) phase power shall be required on all motors, if available to the site. Single phase power will be an acceptable alternative if three (3) phase power is unavailable. Proof that three phase is not available by the power company shall be provided in order to allow single phase.

F. Complete equipment and material submittals shall be submitted for approval prior to ordering of any items.

G. Contractor shall furnish to the engineer on or before final inspection one each of the following:

1. Seal assembly: one complete set for one pump.
2. Bearings: one complete set of bearings for one pump.
3. Two complete sets of record drawings for wet well, electrical, electronic schematics and pump O&M manuals with factory pump curves for pumps installed, copies of all certified test data and inspection data.

H. GSWSA reserves the right to approve or disapprove duplex grinder pump stations on a case by case basis.

CHAPTER 5

PRESSURE FORCE MAINS AND APPURTENANCES

5.1 GENERAL

This section shall include the furnishing of all types of pipe and other incidentals required for the construction of a complete sewer force main system as shown on the drawings and as specified herein. Unless otherwise noted, the materials listed below are acceptable to the Owner for use in sewer force main systems. Should the Contractor desire to use other materials not listed in these specifications, written permission must be obtained from the Owner's Engineer.

All material shall be free from defects impairing strength and durability and be of the best commercial quality for the purposes specified. It shall have structural properties sufficient to safely sustain or withstand strains and stresses to which is normally subjected and be true to detail. All PVC piping 3" and larger shall be green in color.

Velocity in force mains shall be at least two (2) feet per second at design flow. However, lower initial velocities may be permitted by the Authority if provisions to maintain a flushing velocity can be made, or if the wastewater does not contain suspended solids.

Force mains carrying raw domestic sewage shall be at least four (4) inches in diameter (inside diameter), except force mains that follow grinder pump systems or solids interceptor tanks, for which a two (2) inch (inside) diameter force main is approvable.

5.1.1 Submittals

The Contractor shall submit to the Engineer six (6) copies of all submittal data for review and/or approval. Submittals shall include at a minimum: (1) the manufacturer's name, (2) type of material, (3) ASTM, ANSI, AWWA or other quality standard and (4) pressure class. If the materials do not meet the quality standards specified, the submittals will be rejected and other materials submitted as specified. The contractor must obtain approval of all pipe materials prior to commencing construction.
The Contractor shall submit to the Engineer two (2) copies of a certificate of inspection from the pipe manufacturer that the pipe supplied has been inspected at the plant and meets the requirements of these specifications.

5.1.2 Pipe Delivery, Storage, and Handling

Units shall be delivered, handled, and maintained in a manner to avoid damage to the pipe. During shipment, piping shall be tarped on front of trailer to prevent contamination by diesel fumes from truck. Piping shipped uncovered will not be accepted. Pipe found to be contaminated as a result of nonconformance to this requirement will be rejected not be accepted for use. The pipe shall be stored in an open area on high, well-drained land not subject to flooding, mud or other means of contamination. The Contractor shall obtain

written permission from the Owner to schedule all pipe and material purchases and deliveries from the suppliers designated for the project.

Third Party Certification:
The manufacturer shall be subject to random inspection and evaluation by an independent third party in order to assure the purchaser to full compliance with this specification. The third party shall report all findings to GSWSA upon request. The third party selection shall be subject to the approval of GSWSA and shall be provided at no charge.

Testing:
GSWSA shall have free access to that part(s) of the manufacturer's plant involved in work perform to meet requirements of this recommended standard. The manufacturer shall afford the inspector, at no charge, reasonable facilities needed to determine if the pipe meets the requirements of this recommended standard. GSWSA shall have the right to plant inspection for witness testing and conformance to all specifications; all costs including transportation and lodging and meals is to be borne by the manufacturer.

5.2 DUCTILE IRON PIPE

5.2.1 General

Ductile iron pipe shall conform with ASTM Specification A-377, latest revision, GR. 60-42-10. Ductile iron pipe shall conform with ANSI A 21.51 (AWWA C-151), latest revision, as approved by Sect. Comm. A 21, American National Standards Institute. Pipe dimensions shall conform to Federal Specifications WW-P-41C, Type II, push-on joints, Type III, mechanical joints. Each joint of pipe shall be conspicuously marked on the outside of the barrel to readily identify it from cast iron. Thickness class shall be as required by ANSI A 21.51, latest revision, assuming Type 1 & 4 - Class 51;6" through 24" - Class 50.

A. Joints

1) Mechanical Joints:
ANSI Specifications A21.11 (AWWA C-111), latest revision, for three inch pipe and larger, and CEPRA Specification 3-54 and 4-54 for two inch pipe. Bolted mechanical joints shall be used at canal crossings, railroad crossings and where specifically called for on the plans or in the Schedule of Bid Items.

2) Push-on Joints:
Single gasket push-on type joints shall conform with ANSI A 21.11 (AWWA C-111), latest revision. Push-on joints may be used where mechanical joints are not specifically called for on plans or specified above.

3) Flanged Joints:
Flanged joints shall be constructed of ductile iron pipe conforming to ANSI/AWWA C115/A 21.15 Class 53 screwed into flanged drilled and faced per ANSI B 16.1 for

250 lb. working pressure. The pipe shall extend completely through the screwed-on flange. The flange face shall be flat and perpendicular to the pipe centerline.

B. Pipe Lining

Cement mortar lining shall conform with ANSI A 21.5 (AWWA C-104), latest revision and shall be sealed with a bituminous coal tar epoxy exterior coating and Protecto 401 ceramic interior lining. Submittals shall be made for lining approvals.

C. Exterior Coating

The pipe shall have an outside pipe coating of bituminous coal tar epoxy material in accordance with the manufacturer's specifications. The final coat shall be continuous and smooth being neither brittle when subjected to low temperatures, nor sticky when exposed to hot sun. The coating shall be strongly adherent to the pipe at all temperatures.

5.3 POLYVINYL CHLORIDE (PVC) PIPE (C-900)

5.3.1 General

For all C900, C905, SDR-PR, PVC piping and in addition to meeting all applicable AWWA and UniBell standards, the GSWSA reserves the right to reject any pipe not within the dimensional specification tolerances and may also upon visual inspection reject any pipe found to be not free of blisters, cracks, seams, welds or ripples on the ID and/or OD of the pipe and Bell that in the opinion of GSWSA would be in any way detrimental to its intended use and intended purpose of the purchase. All PVC piping shall be green in color.

PVC Pipe in sizes four (4) inches through (12) inches will be in accordance with the latest edition of AWWA C-900, Class 100 psi, and in sizes less than four (4) inches will be in accordance with ASTM D 2241 200 psi SDR 21. PVC pressure piping shall be in accordance with ASTM D 1784 for PVC compounds, ASTM S-3139 for push on joints and ASTM F-477 for rubber gaskets. The pipe furnished will also meet the following specifications:

Tapping All PVC: C-905 should not be direct tapped. Cutting should be done only with a full circle shell-cutter tool. The shell cutter must have sharp teeth and clean teeth. A full circle tapping sleeve should be used. Hole cut must be circular. HDES cut into PVC C-905 pipes in any method other than above are not acceptable to PVC pipe manufacturers and will void pipe warranty.

Hole cutting by any method other than described above could induce stresses into the pipe wall and even hairline cracks which could cause failure of the pipe under pressure.

Third Party Certification:

The manufacturer of all PVC pipe supplied to GSWSA shall be subject to random inspection and evaluation by an independent third party in order to assure the purchaser to full compliance with this specification. The third party shall report all findings to GSWSA upon request. The third party selection shall be subject to the approval of GSWSA and shall be provided at no charge.

A. **C-900 PVC**

C-900 PVC pipe will be pressure class 100 psi meeting the requirements of the AWWA C-900, 97 latest edition, Standard for Polyvinyl Chloride (PVC) Pressure Pipe four (4) inches through twelve (12) inches for water. The pipe will be furnished in twenty (20) feet lengths with smaller lengths comprising no more than fifteen 15 percent of the system installed. The pipe will be cast iron pipe equivalent outside diameters. Joints will be rubber gasket sleeve-type couplings or integral bell (push-on). Pipe bedding requirements will be in accordance with ASTM D 2321 excepts as modified by these specifications.

Pipe will not fail when tested in accordance with AWWA C-900 for sustained pressure, burst pressure, flattening and extrusion quality. Each section of C-900 must pass a hydrostatic proof test at four times its rated class pressure for a minimum of five seconds.

All PVC shall be furnished in factory packaged units and each section of pipe clearly marked with the manufacturer's name pressure class, sizes and appropriate standard.

B. SDR-PR PVC

SDR-PR will meet requirements of ASTM D 2241 and will be 200 psi pipe with Standard Dimension Ration of 21 (SDR-21). Pipe will not fail when tested for the appropriate sustained pressure, burst pressure, flattening and extrusion quality. Installation of Pressure Rated PVC pipe will include an encasement of sand six (6) inches thick around the full perimeter of pipe. Payment for sand will be included in the unit price bid per linear foot of PVC pipe.

The pipe will be furnished in twenty 20 foot laying lengths with no more than fifteen (15) percent of the system comprised of lengths less than twenty (20) feet.

All pipes will be furnished in factory packaged units and each section of pipe will be clearly marked with the manufacturer's name, pressure class, size appropriate standard. All PVC pipe conveying potable water will be stamped with the NSF seal of approval.

The pipe shall be plainly marked with the following information: manufacturer's name, size, material (PVC) type and grade or compound, pressure rating and reference to appropriate product standards.

5.4 POLYVINYL CHLORIDE (PVC) PIPE (C-905)

SDR-PR Thick wall C-905 PVC pipe for large diameters, 14" through 48", shall meet all requirements of AWWA C905-97 latest edition. Unless otherwise specified, specifications are for

DR25 for PVC transmission pipe with Cast Iron outside diameter. Rubber gaskets with pipe lubricant shall be furnished for all joints. The pipe manufacturer shall be a member of and shall provide for conformance to all recommended standard specifications of the Uni-Bell Pipe Association. Pipe shall be furnished in cast iron pipe equivalent outside diameters with rubber-gasketed separate couplings or push-on joints. Pipe and couplings shall not fail when subjected to the following tests; (1) sustained pressure (2) burst pressure (3) flattening and extrusion quality. Tests shall be conducted as outlined in AWWA C-905. Each length of PVC pipe shall pass a hydrostatic integrity test at the factory 2 times the pressure class of the pipe for 5 seconds and/or as outlined in the C-905 standards..

Pipe shall be furnished in 20 ft. laying lengths. Random lengths shall be a minimum of 10 feet long and shall comprise no more than 15 percent of the length of the piping system. Pipe shall be furnished in factory packaged units with each joint plainly marked with the manufacturer's name, pressure class, size, etc.

5.5 POLYETHYLENE PIPE FOR PRESSURE FORCE MAINS

5.5.1 General

The pipe supplied under this specification shall be SDR 17 (unless specified otherwise) high density polyethylene pipe, and shall conform to ASTM 714 and ASTM D 1248 (Type III C, Class C, Category 5, P34). Minimum cell classification values shall be 345434C as referenced in ASTM D 3350 - latest edition. All pipe resin shall be manufactured by the same company that manufactures the pipe itself in accordance with these specifications to insure complete resin compatibility and total product accountability. The fittings supplied in this specification shall be molded or manufactured from a polyethylene compound having a cell classification equal to or exceeding the compound used in the pipe. To insure compatibility of polyethylene resins, all fittings supplied under this specification shall be of the same manufacture as the pipe being supplied. Polyethylene pipe and fittings shall conform to the latest edition of ANSI/AWWA C901 or C904 for ½" – 3" service laterals and C906 for 4" – 63" distribution mains. Material used in manufacture of polyethylene pipe or fittings shall conform to the PE standard code PE 4710.
The pipe shall conform to the physical properties as described herein.

All pipe shall be color coded and/or striped green (for sewer) unless otherwise specifically approved. All pipe shall be stamped with the SDR by the pipe manufacturers.

A. Typical Pipe Physical Properties

PROPERTY	TEST METHOD	UNIT	VALUE
Density	ASTM Method	gms/cc	0.955
Melt Index	ASTM D 1238	gms/10	0.11
	(190/2.16)	min.	
Environmental Stress Cracking Resistance:			
Condition A,B,& C,F-O	ASTM D 1693	hrs.	>5000**
Compressed Ring, F-50	ASTM F 1248	hrs.	>1000
Tenslle Strength, Yield	ASTM D 638	psi	3200
Type IV Specimen	(2”/min.)		
Elongation at Break	ASTM D 638	%	>750
Type IV Specimen	(2”/min.)		
Vicate Softening Temp.	ASTM D 1525	degrees F	257
Brittleness Temp.	ASTM D 746	degrees F	<-180
Flexural Modulus	ASTM D 3350	psi	135,000
Modulus of Elasticity	ASTM D 638	psi	130,000
Hardness	ASTM D 2240	Shore D	65
Coefficient of Linear Thermal Expansion:			
Molded Specimen	ASTM D 696	in./in./deg.	8.3x10-5
Extruded Pipe			1.2x10-4
Thermal Conductivity	Dynatech-Colora	BTU, In./	2.7
	Thermoconductor	ft./2hrs/deg. F	
Long Term Strength:			
73 degrees F	ASTM D 2837	psi	1600
140 degrees F		psi	800
Material Cell			
Classification	ASTM D 3350		345464 C
Material Designation	PPI Recommendation		PE 4710

B. Quality Control

The resin used for manufacturer of the pipe shall be manufactured by the pipe manufacturer, thus maintaining complete control of the pipe quality. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogenous throughout and free of visible cracks, holes, foreign inclusions, or other deleterious defects and shall be identical in color, density, melt index, and other physical properties. GSWSA may request, as part of the quality control records submittal, certification that the pipe produced is represented by the quality assurance testing. Additionally, test results from manufacturer's testing or random sampling by the engineer that do not meet appropriate ASTM standards or manufacturer's representation, may be cause for rejection of pipe represented by the testing. These tests may include density and flow rate measurements from samples taken at selected locations within the pipe wall and thermal stability determinations according to ASTM D 3350, 10.1.9.

GSWSA may request certified lab data to verify the physical properties of the materials supplied under this specification or may take random samples and have them tested by an independent laboratory. Approved manufacturers are Plexco, Driscopipe, CSR, or Authority approved equal.

C. Pipe Delivery, Storage, and Handling:

Truck and shipment units shall be delivered, handled, and maintained in a manner to avoid contamination and damage to the pipe. Piping found to be partially or wholly damaged or contaminated as a result of non-conformance to this requirement will not be accepted for use. The pipe shall be stored in an open area on high, well-drained land not subject to flooding, mud or other means of contamination. Pipe shall not be strung out in ditch areas where contamination will occur. The Contractor shall obtain written permission from the Owner to schedule all pipe and material purchases and deliveries from the suppliers designated for the project. Written permission from property owners selected for pipe storage shall be obtained and approved by GSWSA prior to unloading.

D. Rejection:

GSWSA reserves the right to reject any polyethylene pipe and fittings failing to meet any of the requirements of this specification. Per the manufacturer's recommendations, the following apply to all handling and preservation of the pipe: Shipping, hauling, unloading, stringing and installing HDPE should be done with the care necessary to prevent damage to the pipe. Since all plastics are softer than steel, poor handling can result in abrasions, cuts, gouges, punctures and are causes for rejection.

All pipe shall be carefully examined before installation and damaged pipe removed. Damage that results in reduction of the wall thickness by more than approximately 10% should be cut out and discarded as it may impair long-term service life.

Damaged pipe will be repaired by butt fusion only.

E. Pipe Dimensions:

Pipe supplied under this specification shall have a nominal IPS (Iron Pipe Size) O.D. unless otherwise specified. The pipe size and SDR (Standard Dimension Ratio) of the pipe supplied shall be as specified by GSWSA.

5.5.2 Construction Practices

A. Handling of Pipe

Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe. If the pipe must be stacked for storage, such stacking should be done in accordance with the pipe manufacturer's recommendations. The handling of the pipe should be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment.

B. Repair of Damaged Sections

Segments of pipe having cuts or gouges in excess of 10% of the wall thickness of the pipe should be cut out and removed. The undamaged portions of the pipe shall be rejoined using the butt fashion joining method and as per the specification.

C. Pipe Joining and Directional Boring

Sections of polyethylene pipe should be joined into continuous lengths on the job site above ground. All shavings and cuttings resulting from the fusion operation shall be collected from the on job fusion/cutting site and properly removed off and disposed of from the project site. The joining method shall be the butt fusion method and shall be performed by the manufacturer's trained and certified technicians and in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements, alignment, and fusion pressures. Prior approval of equipment and personnel shall be obtained from GSWSA before fusion begins. Testing pipe sections shall be hydrostatically tested at full test pressure of 100 psi or 1.5 times the working pressure as determined by the Authority after fusing and prior to installation. The contractor shall furnish prior written evidence that the thermal fusion shall be conducted by personnel that have received approved and proper training in the use of fusion equipment according to the recommendations of the pipe supplier and the fusion equipment supplier. The installing contractor shall maintain on file with the Authority a certification of training of personnel

operating the approved equipment for fusion and installation work. The Authority reserves the right to reject at any time the contractors proposed or being used, equipment and personnel as applicable to pipe joining and directional boring. The drilling-coring contractor shall receive prior approval of what manufacturer and product the driller's mud is proposed to be used. The size of the auger head shall be approved by the Authority prior to start of installations.

D. End Connections

Special mechanical joint ends will be required for each end. See standard drawings developed for polyethylene installations for special end conditions.

The HDPE MJ adapter to be size on size. Any required change in pipe diameter shall be made using DI MJ fittings with restraints. HDPE reducers are not allowed. The HDPE MJ transition adapter DR must match the DR of the HDPE bore pipe being installed.

E. Handling of Fused Pipe

Fused segments of pipe shall be handled so to avoid damage to the pipe. When lifting fused sections of pipe, chains or cable type chokers should be avoided. Nylon slings are preferred. Spreader bars should be used when lifting long fused sections. Care should be exercised to avoid cutting or gouging the pipe.

F. Installation

Trenching, installation, backfill and testing shall be in accordance with GSWSA specifications and drawings and special method of installation developed for this specific project. An electronically generated profile and plan shall be provided as a part of the overall project as-built for each directional bore where installed. See Standard Drawing WS 4. The size of the auger head shall be at a minimum diameter to accompany the pipe being installed. The installer shall receive prior approval for the size of the pipe directional drill auger prior to any installation. Upon completion of all drilling, all drillers used and/or lubricant material being used on the job shall be completely removed from the work areas and shall receive inspection approval prior to backfilling any installing excavations.

G. Tracer Wire

Where, Ductile Iron, PVC, or polyethylene pipe is used in sewer force main construction, a continuous # 12 green insulated solid copper tracer wire, approved by the manufacturer for direct burial, shall be installed and taped to the top of the sewer line. The tracer wire shall terminate at each valve or meter and be arranged to allow connection of equipment for tracking pipe and to prevent interference of operating the valve or meter. Standard underground type electrical wire connectors are to be used where splicing is required. All

terminals are to be taped for corrosion and underground deterioration protection. Tracer wire shall be as manufactured by Baron, # 12 AWG, UL, UF, 600F or prior approved equal.

As an alternate, PRO-TRACE copper clad steel conductor tracer wire or prior approved equal may be used. Conductor shall be #12 AWG, green in color, RoHS compliant and rated for direct burial use at 30 volts.

5.5.3 Final Testing

Following the aforementioned test specified in Paragraph C above and after polyethylene piping is installed, back filled and all air removed, the contractor shall apply a hydrostatic pressure of 100 psi or 1.5 times the working pressure as determined by the Authority to the pipe. The test pressure shall be allowed to stand without make-up pressure for a period of time as required by the pipe manufacturer and approved by the engineer to allow for diameter expansion or pipe stretching to stabilize. This stabilization time is approximately 24 hours and will vary depending on field conditions. After the required equilibrium period the test section shall be returned to the original test pressure. All final testing shall be after connection to the main line and shall be in conformance with GSWSA specifications.

5.6 WROUGHT PIPING

5.6.1 General

Wrought steel pipe shall conform to ASTM A-53. Wrought iron pipe shall conform to ASTM A-72. All wrought piping shall be standard strength schedule 40 and shall be galvanized inside and outside.

5.7 PIPE FITTINGS

For all pipe three (3) inches in diameter and greater, fittings will be ductile iron in accordance with AWWA C110/ANSI A 21.10 latest revisions. Ductile iron fittings will be cement mortar lined in accordance with AWWA C110/ANSI 21.4 with an outside coating. An interior and exterior coating of bituminous coal tar epoxy material approximately three (3) mil thick shall be applied and will be continuous and smooth and strongly adherent to the fittings. Fittings will be Class 350 up to twenty-four (24) inches and Class 250 for sizes greater than twenty-four (24) inches. Fittings will be marked in accordance with ANSI 21.10. Mechanical joints will be in accordance with ANSI 21.11. Payment weight will be as listed in ANSI 21.10 or AWWA C-110-71. Fitting weights will be without accessories. The Authority reserves the right to require special interior coatings as applicable to certain wastewater applications of usage. Fittings shall be American Cast Iron Pipe Company, Tyler Union, Sigma or approved equal.

Fittings for pipe less than three (3) inches in diameter will be in accordance with ASTM D 2467 for Schedule 80 fittings.

All bends and fittings may be compact size in accordance with AWWA C153/A21.53 latest revisions. The fitting manufacturer must be approved prior to placement of any orders.

The Authority reserves the right upon inspection of delivered bends and fittings to reject any item not in full conformance to the specifications and that have been damaged (linings or exterior) and/or found to be out of round.

5.7.1 PVC Bends and Restraints

Bends

Fittings approved for PVC use shall be in accordance with AWWA C-900 and C-905 latest editions. PVC bends and fittings shall have the same pressure rating and safety factors as the C-900 and C-905 PVC pipe on which they will be installed. PVC fittings shall not be fiberglass wrapped and shall meet ASTM C1784, D2122, D2564, D2855, D3139 and F466 only in special and specific locations will PVC fittings be allowed to be used.

Joint Restraints

Joint restrainers shall be specifically designed for PVC AWWA C-900 and C-905 pipe and PVC fittings. Joint restrainers shall be the full circle, full contact type or approved equal. They shall be fusion epoxy coated JCM 621 (pipe) and JCM 611 (fittings), Ford Uni Flange, Ebaa Iron with Mega Bond Coating system, Tyler Union or approved equal. The Authority reserved the right to require PVC bends as applicable to certain water and wastewater applications. Submittals shall be made for approval for all projects where PVC bends and joint restraints. See Standard Detail Drawing WS3 for required restraints. All installations shall be per the manufacturer's requirements and no deviation will be allowed.

5.8 PIPE INSTALLATION

5.8.1 General

Pipe shall be installed in accordance with the manufacturer's recommendations and as specified in Chapter 2 of these specifications. Pressure testing shall meet the requirements in Section 6.4.1.

5.8.2 Method of Measurement

Pipe shall be measured from the bell or connection at the beginning of the bell or connection to the end, per linear foot, complete in place and accepted, including the furnishing of all labor, tools, materials, and equipment necessary for trenching, laying, jointing, testing, sterilizing, back filling, connections to existing mains, and all other necessary incidentals.

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CHAPTER 6

FORCE MAIN CONSTRUCTION METHODS

6.1 GENERAL

This section shall include furnishing all labor, tools, equipment and other incidentals required for the construction of the sewer force main system as shown on the drawings and as specified herein. The work shall include laying pipe and setting fittings, valves, hydrants, and services, and pressure testing of the sewer force main system.

Materials shall be as specified in previous sections of these specifications.

6.1.1 Shop Drawings

The Contractor will submit shop drawings as may be specified by the Engineer and the Authority for all pipe and appurtenant items. For piping, the Contractor will submit a notarized sworn statement from the manufacturers stating that inspections and all specified tests have been made and the results comply with the appropriate standards set forth in these specifications.

6.2 PIPE AND FITTINGS

Pipe and fittings shall be laid as directed by the engineer, and located as shown on the drawings. No additional payment will be made due to location changes directed in the field by the engineer. Pipe laying for pressure piping will be in accordance with AWWA Standards and manufacturers recommendations and these specifications for delivering, protecting, handling, storing, laying and use of the pipe to be installed.

6.2.1 TRENCHING

The trench shall be dug to the required alignment and depth as shown on the plans or directed by the engineer, and only so far in advance of the pipe laying as the engineer shall permit. The width of the trench shall be kept at a minimum. The depth of the trench shall generally be sufficient to allow a minimum of three feet of cover over the top of the pipe. The bottom of the trench shall be shaped by hand and shall support the pipe for the entire length. It shall be the responsibility of the Contractor to provide adequate bearing for all pipe lines laid in uncertain soil conditions. If the trench bottom should be softened by flooding, rain or other causes, the unsuitable material shall be removed and replaced with suitable material properly shaped and tamped to grade. The use of timber or other material to support the pipe shall not be accepted.

6.2.2 PIPE LAYING

Force main pipe shall be installed in accordance with ASTM D-2321 or ASTM D-2774, latest revision and with the standards set forth by AWWA C-600, latest revision. All pipe will be laid by experienced workmen with straight lines, even grades, and all joints shall be perfectly fitted. All pipe fittings, valves, hydrants, and accessories shall be carefully lowered into the trench with suitable equipment in a manner that will prevent damage to pipe fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench. Pipe and accessories shall be inspected for defects prior to their being lowered into the trench. Any defective, damaged or unsound material shall be repaired or replaced as directed by the Engineer. All foreign matter or dirt shall be removed from the interior and machined ends of pipe and accessories before it is lowered into position in the trench. Pipe shall be kept clean by means approved by the engineers, during and after installation.

Pipe will be laid on true lines as according to the plans without any unnecessary bending or wandering of the pipe along the right-of-way. Minimum nominal lengths of eighteen (18) feet of pipe sections will be used and installed with a minimum of thirty-six (36) inches of cover.

The trench bottom will be leveled so as to provide a firm, stable, uniform support. Bell holes will be excavated at each joint to assure support is provided along the barrel of the pipe and to permit proper assembly of the joint. Ledge rock, boulders and large stones will be removed within four (4) inches of all sides of the pipe.

There shall be at least a ten (10) foot horizontal separation between sanitary sewer force mains and potable water mains. There shall be an eighteen (18) inch vertical separation at crossing as required in section 3.3.2.

Special Conditions. When it is impossible to obtain the distances specified in section 3.3.2 and section 6.2.2, the Authority may allow an alternative design. Any alternative design shall:

a. maximize the distances between the sewer line and the potable water main and the joints of each;

b. use pipe materials which meet the requirements as specified in SCDHEC Regulation 61- 58.4(D) (1) for the sewer line; and

c. allow enough distance to make repairs to one of the lines without damaging the other

Joints shall be fitted to insure watertight joints and shall be in conformance with manufacturer recommendations. Transition couplings manufactured per AWWA Standards will be used for joining different type pipes.

A) Jointing Mechanical Joint Pipe

1) Joining Existing Bell and Spigot to New Mechanical Joint: Due to the difficulty that may be encountered in attempts to make such a connection of this type, an adapter having a fitting bell and M.J. socket may be used by the Contractor.
2) Cleaning and Assembling Joints: Clean last 8” outside the spigot, and the inside of the bell of mechanical joint pipe to remove oil, grit, tar (other than standard

coating) and other foreign matter from the joint and then paint area clean with an AWWA approved standard lubricant. The ductile iron gland shall then be slipped on the spigot end of the pipe with the extension of the gland toward the socket or bell end. The rubber gasket shall be painted with the standard lubricant and placed on the spigot end with thick edge toward the gland.

3) Bolting of Joints: Push entire section of pipe forward to seat spigot end in the bell. Press gasket into place within the bell, being careful to have the gasket evenly located around the entire joint. Move ductile iron gland along the pipe into position for bolting, insert all bolts, and screw nuts up tightly with fingers. Tighten all nuts with a suitable (preferably torque-limiting) wrench. Tighten nuts that are spaced 180 degrees apart alternately in order to produce equal pressure on all parts of the gland.

B) Jointing Rubber Gasket Pipe (Bell Tite, Tyton, or Equivalent)

1) Cleaning Joint Gasket: Clean gasket and spigot and inside of bell thoroughly to remove all dirt and other foreign matter.

2) Inserting Gasket: Insert gasket furnished by the pipe manufacturer into the gasket seat in the bell. Gasket shall be properly seated in the grooves provided in the pipe bell.

3) Lubricating Gasket and Pipe Spigot: Using a non-toxic vegetable soap, apply a film by hand to the inside surface of the gasket that comes into contact with the entering pipe and to the first 1" of the spigot end of the entering pipe. Use only lubricant specified by the pipe manufacturer.

4) Final Assembling of Joint: Align entering pipe with the bell to which it is to be joined. Enter the spigot end into the bell until it just makes contact with the gasket. Apply sufficient pressure to force the spigot end past the gasket up to solid contact with the bell.

5) Field Cutting Pipe: When it is necessary to field cut pipe with rubber gaskets, chamfer the cut end 1/8 inch X 30 degrees before inserting into a rubber gasket bell.

6) Fittings: Fittings shall be installed where and as show on the plans or as directed by the Engineer. All bends (1/16 to ¼), y-branches, plugs and all other fittings requiring such shall be sufficiently restrained, backed, blocked, or braced to preclude the possibility of their blowing off the main.

7) PVC Pressure Fittings: Four through 12 inch shall meet AWWA C-900 specifications; 14" – 48" shall meet C 905 specifications, PVC pressure fittings greater than eight inch shall meet CSA standard B 137.3-93 and all applicable AWWA and ASTM specifications. Specific and prior approval shall be obtained for the use of PVC fittings.

8) Bell joint restraints shall be used on each side of a bend, valve, and/or fitting. See Detail Drawing for minimum number to be installed on each side. Two bell restraints shall be required on the two joints either side of a directional bore.

9) Mail Boxes: Where mail boxes are encountered during the installation of lines, the mail boxes and posts may be carefully removed temporarily only and shall be replaced immediately after back filling and pipe installation has passed the box location. Said box shall be replaced for use the same day as removed and shall be restored as may be needed to conform to its prior condition with the exception that the distance from the bottom of the box to ground level shall be 43". Any and all necessary replacements of posts and/or boxes needed to conform to these requirements are considered as a part of the overall cost for pipe installation work and no additional compensation will apply.

6.2.3 MECHANICAL THRUST RESTRAINTS

For all bends, fittings that are PVC and/or DIP and that induce pressure which would cause separation of pipe, breakage, etc., shall be mechanically restrained in such a manner that the pressure to be exerted at the point of restraint is transferred to the pipeline for a distance sufficient to prevent separation, breakage, etc.; mechanical restraints shall be per manufacturers recommendations with PVC type and DIP type being of a separate type. MJ fittings shall be restrained with restraints such as Romac Grip Ring, Ebaa Iron Megalug restraints, JCM or Ford Uni Flange. Pipe joints shall be restrained with harness or bell restraints such as Ebaa Iron Series 1700 for slip-joint DIP or Series 1500 for PVC, Romac Grip Ring, JCM Series 600, or Ford Uni Flange. Submittals and their approval are required for all projects. All large diameter restraints shall be epoxy coated or Megabond by Ebaa Iron.

6.2.4 CONCRETE BLOCKING

Concrete thrust blocking shall only be used if mechanical restraints are not feasible. Where mechanical restraints are not feasible, all turns, fittings, etc., which induce pressure that would cause separation of pipe, breakage, etc., shall be blocked with 3,000 lb. concrete. Blocking shall be formed and placed in such a manner that the pressure to be exerted at the point of blocking shall be transferred to firm, undisturbed earth at a maximum load of 2,000 lbs., per square foot. The Contractor shall insure that blocking at all tees, bends, plugs, etc., shall be sufficient to contain all pressure exerted by the pipe up to a pressure of 200 lbs., per square inch hydraulic pressure within the pipe, i.e., pressure at plug 200 X (area of pipe in inches). Blocking shall be constructed as shown on the detail sheet contained in these specifications. The Contractor shall also be responsible for any damage or repairs caused by blowouts of any insufficiently blocked pipe. All installations when concrete which are in contact with fittings and other material shall be wrapped with a minimum of 8 mills of plastic sheeting to prevent bonding of the concrete.

6.2.5 METHOD OF MEASUREMENT

The cost of laying pipe including connection of existing mains, and pressure testing shall be included in the unit price per foot of pipe measured as previously specified. The cost of setting valves, fittings, water services, etc., shall be included in the cost per unit of the respective item measured as specified.

Blocking where specified for fittings shall be measured by the cubic yard of concrete. This item shall include all labor, equipment, and incidentals necessary to properly block all fittings and bends according to the detailed drawings contained herein.

6.3 BORING UNDER HIGHWAYS AND RAILROADS

6.3.1 GENERAL

This section shall include furnishing all labor, tools, equipment and other incidentals required to bore casing pipe under highways or railroads.

Before starting boring operations, the Contractor shall submit to the Engineer an experience record of the proposed boring sub-contractor. Such record shall include a list of equipment and personnel to be used, and a list of at least five previous successful similar installations under highways or railroads within the past five years. Failure to submit an experience record or submittal of a record not meeting these requirements will be cause for rejection of the boring subcontractor.

6.3.2 BORING

Procedures for boring shall be in accordance with the best accepted methods of the construction and as shown on the plans and specified and detailed in these specifications.

A. Boring Under Highways:
Lines installed under highways shall be bored as shown on the detail drawings contained in these specifications. Casings will be installed of the type, size, and thickness as specified herein or on the detail drawings. The Contractor shall be responsible for notifying the South Carolina Department of Transportation at least five days prior to any contemplated work and for securing any required permits for performing the work. All work shall be accomplished under the supervision of the Engineer and the District Engineer of the Department of Transportation or his authorized representative.

1) Carrier Pipe: Carrier pipe used under highways shall of an approved material and installed to the satisfaction of the District Engineer of the Department of Transportation. Carrier pipe shall be of the same material specified for sewer force main construction unless otherwise noted.
The carrier pipe shall be restrained at each end with pipe Meg-a-lugs and rods welded to the casing per standard details. All carrier pipe shall be restrained at each joint within the casing pipe.

2) Casing pipe: The inside diameter of the casing pipe shall not be less than 2 inches greater than the largest outside diameter of the joints and couplings for carrier pipe less than 6" o.d., and 4" greater for carrier pipe 6" or larger. It shall, in all cases, be great enough to easily remove carrier pipe without disturbing the casing pipe.

a. Pipe Sizes 8" and Smaller:

Schedule 40 wrought steel or wrought iron pipe having a wall thickness as shown below may be used for casing pipe 8" and smaller:

SCHEDULE 40 WROUGHT

Diameter of Pipe (In.)	Steel Wall Thickness (In.)	Wrought Iron Wall Thickness (In.)
2	0.203	0.208
4	0.237	0.242
6	0.280	0.286
8	0.322	0.329

b. Pipe Sizes Larger than 8":

Steel pipe casings larger than 8" shall be manufactured from steel having a minimum yield strength of 35,000 psi with the minimum wall thickness as shown below:

Diameter (In.)	Minimum Wall Thickness (In.)
10	0.188
12	0.188
16	0.250
18	0.250
20	0.250
24	0.250
30	0.312
32	0.375

36	0.375

3) Installation: The depth from the roadway surface to the top of the casing pipe at its closest point shall be minimum three feet. The casing pipe ends shall be protected from the entrance of foreign material. The casing pipe shall extend from ditch line to ditch line or toe to toe of till unless otherwise noted on the plans or specified herein. Carrier pipe shall be supported with casing spacers.

   Contractors should provide shoring of boring pits and trenches more than 5 feet deep in accordance with the South Carolina Department of Transportation and Federal Occupational Health and Safety Act.

4) Casing Spacers: Casing spacers shall be prefabricated stainless steel or fabricated steel with polyethylene insulators or all polyethylene construction capable of being securely fastened to the carrier piping. Casing spacers shall be Cascade, CMI, Boyd's or approved equal. A minimum of three spacers shall be used per pipe. See Standard Details. Submittals for approval shall be made for use of casing spacers.

B. Boring Under Railroads:

   All work on railroads rights of way shall be done under the supervision of the Chief Engineer of the railroad, or his authorized representative, who shall be notified at least 15 days before construction is begun. In addition, this work shall only be done in the presence of the authorized representative of the Chief Engineer, and no methods shall be use that, in the opinion of the representative, could be hazardous to the railway.

   1) Carrier Pipe: Carrier line pipe and joints shall be of the material shown on the details of the railroad encroachment agreements. Carrier pipe shall be of the same material specified for force main construction unless otherwise noted. The carrier pipe shall be restrained at each end with pipe meg-a-lugs and rods welded to the casing per standard details. All carrier pipe shall be restrained at each joint within the casing pipe.

   2) Casing Pipe: The inside diameter of the casing pipe shall not be less than 2 inches greater than the largest outside diameter of the joints and couplings for the carrier pipe less than 6" o.d. and 4" greater for carrier pipe 6" and larger. It shall, in all cases, be great enough to easily remove carrier pipe without disturbing the casing pipe. Steel pipe manufactured from steel having a minimum yield strength of 35,000 psi and having a minimum permissible wall thickness as listed below shall be used as casing pipe.

Diameter of Casing Pipe (In.)	Minimum Wall Thickness (In.)
10	0.188
12	0.188
16	0.219
18	0.250
20	0.281
24	0.344
30	0.406
32	0.438
36	0.469

3) Installation: The depth from the base of the railway rail to the top of the casing at the closest point shall not be less than 5'. Also, there should not be less than 3 feet from the bottom of the side ditches to the top of the casing pipe. The casing pipe ends shall be protected from the entrance of foreign materials. The casing shall extend 25 feet either side of the centerline of the railroad track unless otherwise noted on the plans or specified herein. Carrier pipe shall be supported with all stainless steel casing spacers as manufactured by Cascade or approved equal. Contractors shall be required to shore all pits used for boring if it is over 5 feet deep.

4) Casing Spacers: Casing spacers shall be prefabricated stainless steel or fabricated steel with polyethylene insulators or all polyethylene construction capable of being securely fastened to the carrier piping. Casing spacers shall be Cascade, CMI, Boyd, Spider Manufacturer or approved equal. A minimum of three spacers shall be used per pipe. See Standard Details.

6.3.3 METHOD OF MEASUREMENT

Bores shall be measured in linear feet from end to end of casing pipe installed and accepted. This item shall include casing pipe and other materials, tools, equipment, labor and

incidentals required to bore and install casing as shown on the details and as directed by the highway or railroad district engineer and/or resident engineer.

6.3.4 Asbuilt - Requirements

The Contractor shall provide within 14 days of completion of all bores (jack and bores as well as horizontal directional drills) the following:

A. Plan review of bore that shows:
   1) Project name, project #, bore # and bore description
   2) Start location of bore labeled "Start of Bore" with corresponding plan station number and measurements to permanent features (edge of pavement, centerline of road, telephone pedestals, power poles, RCP ends, etc.).
   3) End of location of bore labeled "End of Bore" with corresponding plan station number and measurement to permanent features (edge of pavement, centerline of road, telephone pedestals, power poles, RCP ends, etc.).

B. Profile view of bore that shows:
   1) Project name, project #, bore # and bore description
   2) Vertical depths from existing ground plotted beginning with the "Start of Bore" continuing at 10' intervals until the "End of Bore"
   3) Vertical separations shown between bore and all existing utilities (water, sewer, telephone, electric, TV, gas, storm drainage, etc.).

6.4 PRESSURE AND LEAKAGE TESTS

6.4.1 General

All sections of pressure pipe laid under this contract will be subjected to pressure and leakage testing in accordance with Section 4 of AWWA C-600 and any and all AWWA latest editions, except as modified in these specifications. The main shall be subjected to a hydrostatic pressure test of 100 pounds per square inch for a period of two hours minimum or a minimum of two times the system working pressure. The test pressure to be used is to be 100 psi unless otherwise approved.

After installation and back filling, the lines will be flushed clean and all air expelled from the lines. The Contractor will provide, at his cost and as may be needed, additional and/or new ARV's and outlets for air removal at all high pints in the line to accomplish a complete air free hydrostatic test. Temporary taps may be required to be provided for in order to achieve a complete flush and air removal. Additional permanent and/or temporary air lease points that may be required are to be provided for by the contractor and so additional compensation will be provided. The hydrostatic test pressure at the lowest point in the line will be equal to the

rated working pressure of the pipe unless otherwise specified under Section I "Special Conditions". The Contractor will be responsible for providing all pumps, accurate metering, connections and any other apparatus including gauges for the proper completion of the testing.

The Contractor will conduct all pressure and leakage tests in the presence of the Engineer's representative and a representative of the Authority. Each section of line between valves will be tested in order to check the tightness of valves for a period of fifteen (15) minutes. After the first section of line has been tested, the valve will be opened and the second section and valve(s) tested.

The test will proceed in this manner until an entire area is under pressure. Pressure will be maintained over the entire area for a period of two (2) hours. Allowable leakage in the two (2) hour period will be in accordance with the following table:

Allowable Leakage (GPH/1000LF)

Pipe Size (In.) \ Test Pressure (PSI)	50	100	150	200
2	0.11	0.15	0.18	0.21
3	0.16	0.23	0.28	0.32
4	0.21	0.30	0.37	0.42
6	0.32	0.45	0.55	0.64
8	0.42	0.60	0.74	0.85
10	0.53	0.75	0.92	1.06
12	0.64	0.90	1.10	1.27

*The above chart is for pipe lengths of 18 feet. For lengths of 20 feet multiply allowable leakage by a factor of 0.9. For line sizes not shown in table, the Authority will provide the allowable leakage.

Water for testing will be provided by the Authority for line flushing and testing in conformance with the Authority's latest Extension Policy. Water loss due to improper workmanship will be paid for by the Contractor.

6.5 VALVES, TAPPING SADDLES, PUMPER CONNECTIONS, CHECK VALVES , MARKERS AND APPURTENANCES

6.5.1 General

Valves 8" and smaller shall be provided with special support consisting of a sufficiently tamped trench bottom and crushed stone. Valves 10" and larger shall be supported by concrete pads unless otherwise directed by the Engineer. Crushed stone shall be used to encase the valve up to the height of the valve nut. The bid item unit cost for valves shall include the valve, valve box, valve box collar, concrete markers, bedding and any associated appurtenance necessary for a complete, functional installation.

All valve bonnets and stuffing box and gear box, studs, washers and nuts shall be 316 stainless steel. This is applicable to all size valves.

Valve Extensions and Markers:

Any valve installed at a depth greater than 5' shall have a Nut extension installed to within 2' of the surface. Extensions shall be permanently attached to the valve nut and shall be provided with horizontal spacers for vertical alignment within the valve box. Concrete markers shall be installed for all bends, values and buried manholes. A minimum of two valve markers and/or permanent ties shall be approved as part of the as-built dimensioning process. Main line plug valves, concrete markers for all force mains shall be painted yellow with a painted green top. Markers for pumper connections and air release valves shall be painted green with a yellow top. The number of markers required per location shall be determined by the inspector and O&M Department. See standard details for valves, boxes, extensions and markers.

6.5.2 Valves

a. Eccentric Plug Valves

Complete valve manufactures submittals and catalogs shall be provided to GSWSA which shall include but not be limited to providing specific valve manufacturers information such as flow coefficient (CV), resistance coefficient (K Factor), round solids passage and other data pertinent to the valve review for approval.

Valves shall be of the non-lubricated eccentric plug type with resilient seat seal unless otherwise specified and shall be furnished with end connections as shown on the plans. Main line valves shall be mechanical joint with pipe restraints unless otherwise indicated. Flanged valves shall have flanges in full compliance to ANSI B16.1 Class 125 Standards, including facing, drilling and thickness. Face to face dimensions of flanged valves through 12" size shall be that of standard gate valves. Mechanical joint ends shall be in full conformance to ANSI Standard A21.11.

Port areas for all valves shall be at least 80% of the full pipe area.

Valve bodies shall be of ASTM A-126 Class B, cast iron. All exposed nuts, bolts, springs, washers, etc., shall be 316 stainless steel. Resilient seat seals shall be of Buna-N or Neoprene, suitable for use in sewage service.

Seats shall be non-metallic with seat coating thermally bonded and in full conformance to AWWA Standard C550. Valves shall be furnished with permanent corrosion resistant bearing surfaces in the upper and lower journals designed to withstand full rated bearing loads and provide long life in sewage service. Valves furnished shall have their internal wetted surfaced protected by nonmetallic coatings factory applied, thermally bonded and in full conformance to AWWA Standard C550.

Nominal valve pressure ratings, body flanges and wall thickness shall be in full conformance to all AWWA standards and ANSI B16.1-1975. Valves shall seal leak-tight against full rated pressure in the flow direction and a minimum of 75 psi in the reverse or opposite flow direction.

Each valve shall be given a hydrostatic and seat test by the manufacturer with the results being certified when required by GSWSA. GSWSA may request certified copies of proof-of-design test reports as outlined in AWWA C504-80 Section 5.5. Valves shall have gear actuators with 2" square operating nut and shall be capable of opening valve at rated pressure of 150 psi. All gearing shall be fully enclosed in a suitable housing for underground burial and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. A suitable stop shall be set to provide water tight shut off in the closed position at full rated pressure. All exposed nuts, bolts and washers shall be 316 stainless steel.

Valve actuators for buried or submerged service shall have seals on all shafts and gaskets on the valve and actuator covers to prevent the entry of water. All plug valves shall be side gear operated. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs and washer used in buried service shall be stainless steel or electro plated steel. Valves shall be fitted with cast iron valve boxes and cover with fully adjustable tops for all buried valves.

Eccentric mechanical joint plug valves shall be Milliken, M & H, Clow, Pratt, ValMatic, DeZurik, or approved equal.

Eccentric plug valves only shall be used exclusively on sewer force main projects unless specifically authorized by the Authority's engineer. Butterfly valves shall not be allowed on sewer force mains. Gates valves shall only be allowed on sewer force mains less than 3" in size.

b. Valves for 2" through 12" in Size
Valves for 2" through 12" in size and being used where approved only in lieu of plug valves and/or being used for tapping valves in the size for a wastewater application shall be Mueller Resilient Wedge Gate Valve, with special epoxy coating and with the Everdure stem or a prior approval equal. Submittals are required for all valves. Plug valves are to be used for all force main applications unless otherwise approved for 3" and larger applications. See Section 6.5.6 for tapping valve requirements.

6.5.3 Ball Check Valve

See standard drawings for check valve installations; valves shall be Flygt or approved equal.

6.5.4 Valve Boxes

Gate valves will be fitted with cast iron valve boxes and covers with fully adjustable top for all buried installations. Cast iron valve boxes shall be provided for all valves installed underground. The boxes shall be adjustable to fit the depth of earth cover over the valve and shall be designed so as to prevent the transmission of surface loads directly to the valve or piping and a concrete collar shall be installed around the outside per standard drawings. Stem extensions may be required per standard detail drawings. Valve boxes shall have "SEWER" clearly marked on top cover.

6.5.5 Tapping Sleeves

(To be installed by GSWSA unless otherwise designated.)

A. Mechanical Joint Type Tapping sleeve or all stainless steel with stainless steel flange shall be installed.

Tapping sleeve is to be used in conjunction with a mating tapping valve from same manufacturer. Outlet flange of sleeve to be counter bored per MSS SP-60 for true alignment of tapping valve and tapping machine. Sizes of the outlet are to be available through equal opening of sleeve diameters up to 24".

Sizes 12" and smaller sleeves must be capable of working on Class ABCD Pipe diameters without changing either half of sleeve. Sizes 14" and larger must be specified as to which class size is needed. All sleeves are to include the end joint accessories and split glands necessary to assemble sleeve to pipe. MJ bolts and nuts are to conform to ANSI/AWWA C111.A21.11. No special tools other than standard socket wrench to be required for assembly of sleeve to main. Cast or ductile sleeves shall be coated with asphaltic varnish per Federal Specification TT-V-51, Military Specification MIL C-450, or approved equal.

All tapping sleeves and tapping valves are to be air tested and inspected prior to installation of adjoining pipe systems.

All tapped pipe wall sections, "cookie" coupons after tapping shall be retrieved and turned over to the Authority inspector. The contractor shall verify all taps with the Authority Inspector.

B. Single Seal Type

The tapping sleeve is to be manufactured from gray cast iron meeting or exceeding ASTM A126 Grade B or fabricated T-304 stainless steel in accordance with ANSI/AWWA C-207 Class D ANSI 316.5 CL 150. Sleeve is to be of the lightweight compact type with sealing affected by a single rectangular gasket used inside the sleeve. No other auxiliary means

of sealing ends of sleeve to be necessary. The tapping sleeve is to be used in conjunction with a mating tapping valve from same manufacturer. Outlet flange of sleeve to be counter bored per MSS SP-60 for true alignment of tapping valve and tapping machine. Sizes of outlet are to be available through equal opening of sleeve diameters.

Maximum bolt torque required to seal sleeve to main shall be 90 ft.-lbs. All bolting used shall be stainless steel equal to ANSI/AWWA C111/A21.11 specifications. Sleeve shall be capable of fitting to either cast iron or ductile iron pipe, Class ABCD diameters, without changing either half of sleeve. No special tools other than standard socket wrench to be required for assembly of sleeve to main.

Cast sleeves shall be coated with asphaltic varnish per Federal Specification TT-V-51, Military Specification MIL C-450, or approved equal.

All stainless steel sleeves shall conform to the following:

Shell and Lugs: Stainless steel per ASTM A240, type 304 and type 304L.

Bolts: 5/8" UNC rolled thread, stainless steel per ASTM A 193, type 304. 4" nominal pipe size has 1/2" bolts. Fasteners coated to prevent galling.

Nuts: Heavy hex, stainless steel per ASTM A194, type 304.

Washers: Stainless 304 Steel and plastic lubricating washer.

Gaskets: Virgin SBR per ASTM D2000 MAA 610, compounded for water and sewer service. Other compounds are available on request.

Flange: Stainless steel per ASTM A240, type 304. Approved tapping sleeves are Romac SST No. 3, Smith Bair 665, Mueller H304, JCM 452 or prior approved equal.

All tapping sleeves and tapping valves are to be air tested and inspected prior to installation of adjoining pipe systems.

6.5.6 Tapping Valves

(To be installed by GSWSA unless otherwise designated)

Double Disc Parallel Seat Gate Valves (AWWA). Double disc parallel seat gate valves will be manufactured in accordance with AWWA C-500, latest revision. Valves shall be non-rising stems (NRS) with 2" square operating nut for buried service installations, or outside screw and yoke (OS & T) if noted on plans. Valves shall be manufactured with O-ring stem seals. Valves will be designed for a working pressure of 200 psi for sizes 2" through 12", and 150 psi for valves 14" and larger. Double Disc valves 16" and larger shall be equipped with bypass valves to equalize pressure on both sides of gate. All valves 24" and larger shall be equipped with gearing, rollers, tracks, and scrapers as needed for horizontal installation. Valve bodies

will be of heavy cast iron with corrosion resistant parts and coatings, high tensile manganese bronze stems and bronze disc rings. Flanged valves shall be in conformance with ANSI B 16.1, Class 125. Tapping valves shall have flanged inlet end with centering ring and a mechanical joint outlet end. All buried service gate valves shall be fitted with cast iron valve boxes and cover with fully adjustable tops. Double disc gate valves shall be Mueller, American Flow Control, M & H Clow, or approved equal.

All tapping valves used for wastewater application regardless of size shall have the interior coated with a thermonsetting, epoxy coated and shall be Mueller Resiliant Wedge Gate Valve with the Everdure stem or American Flow Control with a special stem material equal to the everdure stem.

6.5.7 Pumper Connections

Pump connections shall be installed per GSWSA Standard Detail Drawings. Unless otherwise specified all pumper connections shall be 6".

6.5.8 Check Valve Assemblies

Check valve assemblies shall be installed per Standard Detail Drawings for size, valves and location.

6.6 AIR AND VACUUM RELEASE VALVE ASSEMBLIES

6.6.1 General

This section covers the work necessary for furnishing and installing the air and vacuum release valve assemblies, complete per the adopted standard drawing detail.

An automatic air relief valve shall be placed at high points in the force main sewer to prevent air locking. Vacuum relief valves may be necessary to relieve negative pressures on force mains. The Authority may require alternative designs in order to reduce possible odor problems from air relief valves located in highly populated areas.

6.6.2 Materials

Main Line connection shall be double-strap service saddle with AWWA thread corporation stop, tap, and neoprene gaskets. Service saddles shall be adequate for use with the size, type, and class of the forcemain pipe and shall be ROMAC or approved equal.

6.6.3 Combination Air and Vacuum Release Valves

The air and release valves shall be designed to operate under working pressures of 150 psi and shall have been tested at a pressure not less than 300 psi, and be 1 inch in size with iron pipe threads on the inlet. Air and vacuum release valves shall have cast iron body and cover with special corrosion protection. Float guides, bushings, and lever pin shall be stainless steel

or bronze. The air and vacuum release valves shall be as manufactured by A. R. I. (model to be approved by Authority) or approved equal. All sewage air and air vacuum valves shall be of the short body (length) type only, complete per the adopted standard drawing detail.

6.6.4 Air Release Valves

Air release valves shall have plastic or stainless steel body and cover. Float guides, bushings, and lever pin shall be stainless steel or bronze. The air release valves shall be designed to operate at a design pressure of not less than 150 psi. Inlet size shall be 2 inch NPT. The air release valves shall be A. R. I. (model to be approved by Authority), Bermad (model to be approved by Authority), or approved equal. All valves shall be of the short body (length) type. All material used above the tapping sleeve shall be stainless steel. A stainless steel cut-off ball valve shall be located within 10 inches below the air release valve.

6.6.5 ARV and Vacuum Release Valves Vault

The air release and vacuum release valve vault or enclosure shall be per the adopted standard drawing detail.

6.6.6 Pipe and Malleable Iron Fittings

The pipe used for the air release valve assemblies shall be Schedule 40 stainless steel pipe or approved equal.

6.6.7 Workmanship

a. Tapping Pipe
   On existing force mains or force mains accepted by GSWSA, the pipe shall be tapped and service saddle installed by GSWSA Personnel unless otherwise approved.
a. Testing
   Air and vacuum release valve assemblies shall be tested in conjunction with the pipeline.