TECHNICAL SPECIFICATIONS

FOR THE

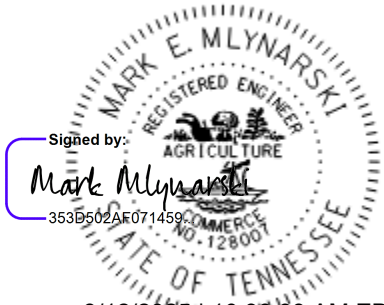
MOUNT CARMEL
WASTEWATER TREATMENT PLANT IMPROVEMENTS
PHASE 1B

FOR THE

TOWN OF MOUNT CARMEL

HAWKINS COUNTY, TENNESSEE

JUNE, 2025



- Prepared By -

Johnson, Mirmiran & Thompson, INC.
1909 Ailor Ave
Knoxville, Tennessee 37921
Telephone: (865) 546-5800
www.jmt.com

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FOR
TOWN OF MOUNT CARMEL
HAWKINS COUNTY, TENNESSEE

TECHNICAL SPECIFICATIONS

SECTION 01010 - SUMMARY OF THE WORK

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division-1 Specification sections, apply to work of this section.

CONTRACT DOCUMENTS:

The work shall be executed in accordance with the specifications, addenda, and the drawings.

PROJECT DESCRIPTION:

The project consists of making improvements to the existing Wastewater Treatment Plant owned and operated by the Town of Mount Carmel in Hawkins County, Tennessee. The work includes bringing secondary clarifier number 1 back into service by replacing the effluent launders, installing a full radius skimmer and beach, upgrading piping and valves, replacing the drive cage, truss arms/ flights, suction arm, center pier, influent well, skimmer and scum trough, weirs and baffles, and necessary appurtenances. The project also includes upgraded pumps and controls to the plant drainage pump station, new piping that connects PDPS and EQ basin and will be upsized to 6”, valves, a new precast concrete wetwell, and electrical and instrumentation upgrades. The last part of the project includes replacement of existing blowers to meet current and projected plant demands. Additional work includes miscellaneous work in the yard piping, site grading, minor concrete repair, secondary clarifier dredging and cleaning, and other support facilities.

GENERAL:

1. Construction work shall be conducted without altering the current operation and maintenance of the existing wastewater treatment plant and without the plant operator’s approval. No unauthorized bypassing of treatment units of the existing treatment plant will be permitted during the construction. The Contractor will be responsible for any fines, remedial work and other items which may result if such bypasses occur or for violations of treatment plant permit which result from actions of the Contractor.

2. The Contractor shall take time to familiarize himself with the location of existing wastewater, water, and other utility lines prior to construction.

3. The Contractor shall provide temporary piping, bypass pumping, or electrical provisions as noted on the Drawings or as deemed necessary to complete the work. Relocation of the temporary lines shall be done in a way not to interfere with other work performed at the site. Alternate routes of the temporary lines will be considered as requested by the Contractor. Temporary lines can be located above or below ground providing they are protected, remain operational and operate satisfactory.

4. All lines disconnected due to the nature of work shall be plugged or removed where applicable.

5. Perform work on the existing raw wastewater force mains during low or no flow periods to minimize impact to plant operations. Coordinate such work with Engineer and Owner for consideration.

6. Consult with plant operator on emergency/backup scenario needs.

7. Contractor shall be required to hire the services of a geotechnical engineer to assist in the evaluation of soil conditions during site grading and foundation construction. Such services will be covered by an allowance.

8. Concrete cylinder testing and other concrete related quality control tests will be required per the technical specifications. Such tests will also be covered by an allowance.

9. Following construction of the new units and lines, provisions shall be made to direct the raw wastewater flow into the new system in a manner acceptable to the Engineer. Temporary lines above ground shall be removed. Those below ground may be removed or abandoned.

10. The Contractor shall construct and make operational all equipment, tanks, piping and controls as shown on plans and included in specifications.

11. Contractor shall review and implement recommendations from the geotechnical report included as part of the contract documents. All site grading, excavation to established subgrade elevations, including rock excavation, shall be paid by the lump sum contract amount and won't be subject for additional reimbursement. Any additional work required below established subgrade elevations, to include bedrock removal, undercutting, and/or backfill shall be paid via a change order and by an allowance.

12. Items not specifically mentioned above, shown on the construction drawings, noted elsewhere in these specifications, or necessary for the installation and operation of such a referenced system shall be part of this work as well.

13. The Contractor shall be responsible to implement and maintain the following services:

    - Soil Erosion and Slope Protection Plan as required by the local authority.
    - Submit for review and approval Sequence of Construction Schedule to Owner/Engineer.

14. The Contractor shall provide record drawings to document the approved work and installed systems. Project approved deviations and field changes shall be documented by the Contractor on the record drawings. Record drawings shall be consistent with the requirements of the technical specifications. Drawings shall be submitted to the Owner/Engineer for approval before being deemed complete.

PROGRESS SCHEDULE, REPORTS AND RECORDS:

Progress schedules, reports and records required are covered in Section 01310.

SURVEY CONTROL:

The Engineer shall provide horizontal and vertical control staking prior to the beginning of construction. The Contractor shall be responsible for maintaining and replacing the control staking and staking actual lines, manholes, basins, etc.

PROTECTION OF PROPERTY AND PERSONS:

The Contractor is cautioned that in many areas, limited working room is available. Therefore, special precautions must be taken by the Contractor in order to comply with the General Conditions.

The Contractor shall thoroughly document the existing condition of all structures, landscaping, and improvements located in all locations where the construction work may result in actual damage or in damage claims. The method of providing this documentation of existing conditions shall be acceptable to the Engineer, and a complete set of the documentation shall be available to the Owner and the Engineer to help settle any disputes which may arise concerning that work is required to return property to its original condition or concerning property damage. This documentation shall be submitted to the Engineer prior to the first payment estimate.

NAMES OF MANUFACTURERS:

Names of manufacturers, catalog numbers, etc. when used in these specifications are used only as general descriptive references. Equipment and products of equal quality and performance will be acceptable.

DAMAGE TO VEGETATION:

Reasonable care shall be taken during construction to avoid damage to vegetation. Ornamental shrubbery and tree branches shall be temporarily tied back, where appropriate, to minimize damage. Trees which receive damage to branches shall be rimmed of those branches to improve the appearance of the tree. Tree trunks receiving damage from equipment shall be treated with a tree dressing. All disturbed areas shall be restored to their original condition.

VISITING THE PREMISES:

The Contractor, before submitting his bid on the work, must visit the site and familiarize himself with all existing conditions.

As a result of having visited the premises, the Contractor shall be responsible for the installation of the work as it relates to such existing conditions.

The submission of a bid will be considered an acknowledgment on the part of the bidder of his visitation to the site.

PERMITS AND INSPECTIONS:

Unless otherwise distinctly hereinafter specified, this Contractor shall apply and pay for all necessary permits, fees and inspections required by any public authority having jurisdiction. Acreage charges, bonds, property assessments and facilities charges shall not be construed to be a part of this contract.

PART 2- PRODUCTS

Where materials or equipment are specified by patent, proprietary name, or name of the manufacturer, such specifications shall be deemed to be used for the purpose of establishing a standard for that particular item. The Contractor may recommend the substitution of any material, equipment, or article which he thinks is equal in every respect to that indicated or specified, and if, in the opinion of the Engineer, such material, article or piece of equipment is of equal substance and function of that specified, the Engineer may approve its substitution and use by the Contractor. If the proposed equipment by the contractor does not meet the specifications, the contractor shall furnish and install the equipment specified as the basis of design.

The selection of equal equipment or deduct alternate selections shall be at the expense of the installing contractor. Redesign of structures, pipe relocation, electrical and site modifications, and all other design and operational requirements brought about by the substitution shall be addressed by the contractor and submitted for approval along with any other information requested by the Engineer. The Engineer has the right to request engineering drawings that are stamped by a certified engineer as deemed necessary. The number of units, capacity, volumes and all other design criteria need to be met or exceeded for the equipment to be considered equal.

SPACE LIMITATION:

The Contractor's attention is called to the space available for all proposed equipment and special care shall be taken in selecting equipment to fit the space available if other than specified equipment shall be proposed. Approval by the Engineer of alternate equipment shall be tested only on capacities, general construction and merit of manufacturer and it shall remain the responsibility of the Contractor to select equipment that will fit space provided and which can be installed to provide satisfactory operation and maintenance conditions.

SHOP DRAWINGS:

Shop Drawings, Product Data, and Sample Requirements are included in Section 01340.

SIGNS:

Construction identification signs, where indicated, shall be constructed as shown on the Drawings and included in these Contract Documents. When required, the sign(s) shall be erected prior to the first pay estimate and removed upon project completion.

PART 3- EXECUTION (Not Applicable)

PART 4- PAYMENT

Payment for all work included in these contract documents will be lump sum.

END OF SECTION 01010

SECTION 01025 - MEASUREMENT AND PAYMENT

PART 1 - GENERAL

SCOPE

A. The Bid lists each item of the Project for which payment will be made. No payment will be made for any items other than those listed in the Bid.

B. Required items of work and incidentals necessary for the satisfactory completion of the work which are not specifically listed in the Bid, and which are not specified in this section to be measured or to be included in one of the items listed in the Bid, shall be considered as incidental to the work. All costs thereof, including Contractor's overhead costs and profit, shall be considered as included in the lump sum or unit prices bid for the various items. The Contractor shall prepare the Bid accordingly.

PROJECT REQUIREMENTS

A. Work includes furnishing all plant, labor, equipment, tools, and materials not furnished by the Owner, and performing all operations required to complete the work satisfactorily, in place, as specified and as indicated on the Drawings.

B. All estimated quantities stipulated in the Bidder’s Unit Price Form or other Contract Documents are approximate and are to be used only:

1. As a basis for estimating the probable cost of the Work.

2. For the purpose of comparing the bids submitted for the Work.

C. The basis of payment for work and materials will be the actual amount of work done and materials furnished. Payment for assessment and assessment- related activities or any other items of work for payment will be made on a linear foot or each based on the Contractor’s measurement, contingent on verification by the Owner or Owner’s Representative. Contractor agrees he will make no claim for damages, anticipated profits, or otherwise on account of any difference between the amounts of work actually performed and materials actually furnished.

D. When submitting pay requests for periodic payment, the following documentation should be submitted at a minimum:

1. Contractor Payment Checklist.

2. Application for Payment Form.

3. Payments Summary Sheet.

4. Narrative of Work Performed.

5. Updated Schedule for Assigned Work Activities.

6. Photo Documentation of Construction Activities Illustrating Pre and Post Conditions.

E. Additional instructions and/or requirements may be provided by the Owner or Engineer at the project Pre-Construction meeting.

DESCRIPTIONS

A. Measurement of an item of work will be by the unit indicated in the Bid.

B. Final payment quantities shall be determined from the record drawings. The record drawing lengths, dimensions, quantities, and the like shall be determined by a survey after the completion of all required work. Said survey shall conform to Section 01340 of these Specifications. The precision of final payment quantities shall match the precision shown for that item in the Bid.

C. Payment will include all necessary and incidental related work not specified to be included in any other item of work listed in the Bid.

D. Unless otherwise stated in individual sections of the Specifications or in the Bid, no separate payment will be made for any item of work, materials, parts, equipment, supplies, or related items required to perform and complete the work. The costs for all such items required shall be included in the price bid for the item of which it is a part.

E. Payment will be made by extending unit prices multiplied by quantities provided and then summing the extended prices to reflect actual work. Such price and payment shall constitute full compensation to the Contractor for furnishing all plant, labor, equipment, tools, and materials not furnished by the Owner and for performing all operations required to provide to the Owner the entire Project, complete in place, as specified and as indicated on the Drawings.

F. “Products” shall mean materials or equipment permanently incorporated into the work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

ITEM NUMBERS AND DESCRIPTION

A. MOBILIZATION – To include all things necessary for the contractor to mobilize any

forces and equipment that is required to perform the work. This is to be paid on a lump sum basis.

B. BY-PASS PUMPING – To include all materials, labor and equipment necessary for maintaining continuous wastewater treatment plant operations. This is to be paid on a lump sum basis.

C. BLOWERS – To include all materials, labor, and equipment necessary for installation of two (2) blowers, including but not limited to selective demolition of existing blowers, piping and electrical components, installation of new blowers, piping, valving, electrical components and wiring, and any other necessary miscellaneous work. This is to be paid on a lump sum basis.

D. PLANT DRAINAGE PUMP STATION – To include all materials, labor, and equipment necessary to replace existing pump station's pumps, railing, chains, piping, valving, controls, and any other supporting components as described in the plans or these specifications. This work is to be paid on a lump sum basis.

E. 6" PVC SANITARY FORCE MAIN – To include all materials, labor, and equipment necessary to install a new 6" sanitary force main from plant drainage pump station to existing headworks. The work includes, but is not limited to excavating, trenching, bedding, pipe laying, testing, as well as installing any necessary fittings, valving, and other appurtenances. This work is to be paid on a linear foot basis.

F. SECONDARY CLARIFIER COMPONENTS – To include all materials, labor, and equipment necessary to replace components of secondary clarifier No. 1 as specified in the plans and specifications. This work is to be paid on a lump sum basis.

PART 4 – PAYMENT (NOT USED)

END OF SECTION 01025

SECTION 01200 - PROJECT MEETINGS

PART 1 - GENERAL

1.1 SCOPE

A. This section specifies administrative and procedural requirements for project meetings including but not limit to:

1. Pre-Construction Conference.
2. Pre-Installation Conferences.
3. Coordination Meetings.
4. Progress Meetings.

B. Construction schedules are specified in section 01310.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplemental Conditions or General Provisions and other Division 1 specification sections, apply to this section.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 PRE-CONSTRUCTION CONFERENCE

A. Attend and participate in a pre-construction conference and organizational meeting at the project site or other convenient location after execution of the “Notice of Award” and prior to commencement of construction activities. Conduct the meeting to review responsibilities and personnel assignments.

B. Attendees. The Owner, Engineer and their consultants, the contractor and its superintendent, major subcontractors, manufacturers, suppliers and other concerned parties shall each be represented at the conference by persons familiar with and authorized to conclude matters relating to the work.

C. Agenda. Discuss items of significance that could affect progress including such topics as:

1. Tentative construction schedule.
2. Critical work sequencing.
3. Designation of responsible personnel.
4. Procedures for processing field decisions and Change Orders.
5. Procedures for processing Applications for Payment.
6. Distribution of Contract Documents.
7. Submittal of shop drawings, product data and samples.

8. Preparation of record documents.
9. Use of the premises.
10. Office, work and storage areas.
11. Equipment deliveries and priorities.
12. Safety procedures.
13. First aid.
14. Security.
15. Housekeeping.
16. Working hours.

3.2 PRE-INSTALLATION CONFERENCES

A. Conduct a pre-installation conference at the site before each construction activity that requires coordination with other construction. The installer and representatives of manufacturers and fabricators involved in or affected by the installation, and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise the Engineer of scheduled meeting dates.

1. Review the progress of other construction activities and preparations for the activity under consideration at each pre-installation conference, including requirements for:

    1. Contract documents.
    2. Options.
    3. Related change orders.
    4. Purchases.
    5. Deliveries.
    6. Shop drawings, product data and quality control samples.
    7. Possible conflicts.
    8. Compatibility problems.
    9. Time schedules.
    10. Weather limitations.
    11. Manufacturer's recommendations.
    12. Compatibility of materials.
    13. Acceptability of substrates.
    14. Temporary facilities.
    15. Space and access limitations.
    16. Governing regulations.
    17. Safety.
    18. Inspection and testing requirements.
    19. Required performance results.
    20. Recording requirements.
    21. Protection.

2. Record significant discussions and agreements and disagreements of each conference, along with the approved schedule. Distribute the record of the meeting to everyone concerned, promptly, including the Owner and Engineer.

3. Do not proceed if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to

performance of work and reconvene the conference at the earliest feasible date.

3.3 COORDINATION MEETINGS

A. Conduct project coordination meetings at regularly scheduled times convenient for all parties involved. Project coordination meetings are in addition to specific meetings held for other purposes, such as regular progress meetings and special pre-installation meetings.

B. Request representation at each meeting by every party currently involved in coordination or planning for the construction activities involved.

C. Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

3.4 PROGRESS MEETINGS

A. Conduct progress meetings at the project site at regularly scheduled intervals but not less than monthly. Notify the Owner and Engineer of scheduled meeting dates. Coordinate dates of meetings with preparation of the payment request.

B. Attendees. In addition to representatives of the Owner and Engineer, each subcontractor, supplier or other entity concerned with current progress or involved in planning, coordination or performance of future activities shall be represented at these meetings by persons familiar with the Project and authorized to conclude matters relating to progress.

C. Agenda. Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the current status of the project.

1. Contractor's Construction Schedule: Review progress since the last meeting. Determine where each activity is in relation to the Contractor's Construction Schedule, whether on time or ahead or behind schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the contract time.

2. Contractor's Submittal Schedule: Review progress since the last meeting. Determine where each activity is in relation to the Contractor's Submittal Schedule, whether on time or ahead or behind schedule. Determine how submittals behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the contract time.

3. Review the present and future needs of each entity present, including such items as:

1. Interface requirements.
2. Time.
3. Sequences.
4. Deliveries.
5. Off-site fabrication problems.
6. Access.
7. Site utilization.
8. Temporary facilities and services.
9. Hours of work.
10. Hazards and risks.
11. Housekeeping.
12. Quality and work standards.
13. Change Orders.
14. Documentation of information for payment requests.

D. Reporting. No later than 3 days after each progress meeting date, distribute copies of minutes of the meeting to each party present and to other parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.

1. Schedule Updating: Revise the construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue the revised schedule concurrently with the report of each meeting.

PART 4 - PAYMENT

Payment for the meetings and associated requirements shall be part of the lump sum amount.

END OF SECTION 01200

SECTION 01252 - WEATHER DELAYS

PART 1 - GENERAL

1.1 EXTENSIONS OF CONTRACT TIME

A. If the basis exists for an extension of time in accordance with the Contract Documents, an extension of time on the basis of weather may be ranted only for the number of Weather Delay Days in excess of the number of days listed as the Standard Baseline for that month.

1.2 STANDARD BASELINE FOR AVERAGE CLIMATIC RANGE

A. The Owner has reviewed weather data available from the National Oceanic and Atmospheric Administration and determined a Standard Baseline of average climatic range for the State of Tennessee.

B. Standard Baseline shall be regarded as the normal and anticipatable number of calendar days for each month during which construction activity shall be expected to be prevented and suspended by cause of adverse weather. Suspension of construction activity for the number of days each month as listed in the Standard Baseline is included in the Work and is not eligible for extension of Contract Time.

C. Standard Baseline is as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
12	11	8	7	7	6	7	5	4	5	6	11

1.3 ADVERSE WEATHER AND WEATHER DELAY DAYS

A. Adverse Weather is defined as the occurrence of one or more of the following conditions which prevents exterior construction activity or access to the site within twenty-four (24) hours:

1. Precipitation (rain, snow, or ice) in excess of one-tenth inch (0.10") liquid measure.

2. Temperatures which do not rise above 32 degrees F by 10:00 a.m.

3. Temperatures which do not rise above that specified for the days construction activity by 10:00 a.m., if any is specified.

4. Sustained wind more than twenty-five (25) m.p.h.
5. Standing snow in excess of one inch (1.00").

B. Adverse Weather may include, if appropriate, “dry-out” or “mud” days:

1. For rain days above the standard baseline;

2. Only if there is a hindrance to site access or sitework, such as excavation, backfill, and footings; and,

3. At a rate no greater than 1 make-up day for each day or consecutive days of rain beyond the standard baseline that total 1.0 inch or more, liquid measure, unless specifically recommended otherwise by the Designer.

C. A Weather Delay Day may be counted if adverse weather prevents work on the project for fifty percent (50%) or more of the contractor’s scheduled workday, including a weekend day or holiday if Contractor has scheduled construction activity that day.

1.4 DOCUMENTATION AND SUBMITTALS

A. Submit daily jobsite work logs showing which and to what extent construction activities have been affected by weather on a monthly basis.

B. Submit actual weather data to support claim for time extension obtained from nearest NOAA weather station or other independently verified source approved by Designer at beginning of project.

C. Use Standard Baseline data provided in this Section when documenting actual delays due to weather in excess of the average climatic range.

D. Organize claim and documentation to facilitate evaluation on a basis of calendar month periods and submit in accordance with the procedures for Claims established in the Contract Documents.

E. If an extension of the Contract Time is appropriate, it shall be affected in accordance with the provisions of the General Conditions, and the applicable General Requirements.

END OF SECTION 01252

SECTION 01310 - SCHEDULES AND REPORTS

PART 1 – GENERAL

A. SUMMARY

1. General. This section specifies administrative and procedural requirements for schedules and reports required for proper performance of the work.

2. Coordination. Each prime Contractor shall closely coordinate scheduling and reporting with the scheduling and reporting of other prime Contractors.

3. Schedules required include:

    1. Preliminary Construction Schedule, including Submittals Tabulation.
    2. Contractor's Construction Schedule.
    3. Submittal Schedule.
    4. Schedule of Values.

4. Reports required include:

    1. Daily Construction Reports.
    2. Material Location Reports.
    3. Field Correction Reports.
    4. Spare Parts Inventory Reports.
    5. Equipment Start-up Report and Certifications.

5. Project Meeting Minutes are included in Section 01200, Project Meetings.

B. RELATED DOCUMENTS

1. Drawings and General Provisions of Contract, including General and Supplemental Conditions or General Provisions and other Division 1 specification sections, apply to this section.

C. PRELIMINARY CONSTRUCTION SCHEDULE

1. Bar Chart Schedule. Submit a preliminary horizontal bar chart type construction schedule within 7 days of the date established for commencement of the work.

2. Bar Chart Schedule. The Contractor for General Construction shall submit a preliminary horizontal bar chart type construction schedule, with a copy to each prime Contractor, within 7 days of the date established for commencement of the work. Within 5 working days of this submittal, each other prime Contractor shall submit a matching preliminary horizontal bar chart schedule showing their construction operations sequenced and coordinated with general construction.

    1. Provide a separate time bar for each significant construction activity. Coordinate each element on the schedule with other construction activities. Schedule each construction activity in proper sequence. Provide a continuous vertical line to identify the first working day of each week.

2. Indicate completion of the work in advance of the date established for substantial completion.

3. If adjustments are necessary for sequencing and coordination of the work, the Contractor for general construction shall arrange a meeting with the other prime Contractors at the earliest possible date. At this meeting each prime Contractor shall negotiate reasonable adjustments to their schedules.

3. Submittal Tabulation. With the submittal of the preliminary construction schedule, include a tabulation by date of submittals required during the first 90 days of construction. List those submittals required to maintain orderly progress of the work, and those required early because of long lead-time for manufacture or fabrication.

1. At the Contractor's option, submittal dates may be shown on the schedule, in lieu of being tabulated separately.

D. CONTRACTOR'S CONSTRUCTION SCHEDULE

1. Bar Chart Schedule. Prepare a comprehensive, fully developed, horizontal bar chart type Contractor's construction schedule based on the preliminary construction schedule and on whatever updating and feedback was received since the start of the project.

2. Bar Chart Schedule. The Contractor for general construction shall secure time commitments for performing critical construction activities from each of the other prime Contractors and shall prepare a combined construction schedule for the entire project. The Schedule shall be a comprehensive, multi-sheet, integrated, fully developed horizontal bar chart type schedule based on the preliminary construction schedules and reflecting updating and feedback received since the start of the project.

1. Submit the schedule within 60 days of the date established for commencement of the work.

2. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week.

1. If practical, use the same breakdown of units of the work as indicated in the "Schedule of Values."

3. For significant construction activities that require 3 months or longer to complete, indicate an estimated completion percentage in 10 percent increments within the time bar. As work progresses, place a contrasting mark in each bar to indicate actual completion percentage.

4. Prepare the schedule on a sheet, or series of sheets, of stable transparency, or other reproducible media, of sufficient width to show data clearly for the entire construction period.

    1. Show the activities of each prime contract on a separate sheet.

    2. Prepare a simplified summary sheet indicating the combined construction activities of the prime contracts.

5. Secure time commitments for performing critical elements of the work from parties involved. Coordinate each element on the schedule with other portions of the work; include minor elements involved in the overall sequence of the work. Show each construction activity in proper sequence. Indicate graphically sequences necessary for completion of related portions of the work.

6. Coordinate the Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests and other required schedules and reports.

7. Indicate completion of the work in advance of the date established for substantial completion. Indicate substantial completion on the schedule to allow ample time for the Engineer's administrative procedures necessary for certification of substantial completion.

3. Work Stages. Use crosshatched bars to indicate important stages of construction for each major portion of the work.

4. Such stages include, but are not necessarily limited to:

    1. Subcontract awards.
    2. Purchases.
    3. Mockups.
    4. Fabrication.
    5. Sample testing.
    6. Deliveries.
    7. Installation.
    8. Testing.
    9. Adjusting.
    10. Curing.
    11. Start-up and placement into final use and operation.

5. Distribution. Following the Engineer's response to initial submittal of the Contractor's construction schedule, print and distribute copies to the Engineer, Owner, separate contractors, subcontractors, suppliers, fabricators, and other parties required to comply with scheduled dates.

    1. Post copies of the schedule in the project meeting room and temporary field office.

2. When revisions are made, distribute the updated schedule to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the work and are no longer involved in performance of construction activities.

6. Schedule Updating. Revise the schedule immediately after each meeting or other activity, where revisions have been recognized or made. Issue the updated schedule concurrently with report of each meeting.

E. SUBMITTAL SCHEDULE

1. Prepare a complete submittal schedule concurrent with the development of the Contractor's construction schedule. Submit the schedule within 60 days of the date established for commencement of the work.

    1. Coordinate submittal schedule with the list of subcontracts, Schedule of Values, Materials and Equipment, as well as the Contractor's construction schedule.

    2. Prepare the schedule in chronological order; include submittals listed on the tabulation of submittals required during the first 90 days of construction. Provide the following information on the schedule:

        1. Schedule date for the first submittal.
        2. Related section number.
        3. Submittal category.
        4. Name of subcontractor.
        5. Description of the part of the work covered.
        6. Scheduled date for resubmittal.
        7. Scheduled date of the Engineer's final release or approval.

2. Distribution. Following the Engineer's response to initial submittal, print and distribute the schedule to the Engineer, Owner, separate Contractors, subcontractors, suppliers, fabricators, and other parties required to comply with submittal dates indicated.

    1. Post copies in the project meeting room and temporary field office.

    2. When revisions are made, distribute the updated schedule to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned part of the work and are no longer involved in the performance of construction activities.

3. Schedule Updating. Revise the schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue the updated schedule concurrently with report of each meeting.

F. SCHEDULE OF VALUES

1. Prepare and submit a schedule of values established in the Agreement within 15 days of the date established for commencement of the work.

1. Refer to the Bid Schedule, for a listing of categories of work where unit prices are required.

2. Refer to individual specification sections for portions of the work where the establishment of unit prices is required. Methods of measurement and pricing are specified in these sections.

2. Prepare the schedule in tabular form, including the following items:

1. Name of the part of the work.
2. Related specification section.
3. Name of subcontractor assigned.
4. Unit of measurement.
5. Price per unit.

3. Distribution. Distribute to the Owner, Engineer, and each party involved in performance of the portion of the work, where established unit prices could come into force and effect.

4. FOR LUMP SUM PROJECTS: Following review by the Owner and Engineer, revise the schedule of values to correct any elements which the Owner and Engineer find unacceptable. After revision, the schedule of values shall be submitted for further review.

G. REPORTS

1. Daily Construction Reports. Prepare a daily construction report, recording the following information concerning events at the site; and submit duplicate copies to the Engineer at weekly intervals:

1. List of subcontractors at the site.
2. List of separate contractors at the site.
3. Approximate count of personnel at the site.
4. High and low temperature, general weather conditions.
5. Accidents (refer to accident reports).
6. Meetings and significant decisions.
7. Unusual events (refer to special reports).
8. Stoppages, delays, shortages, losses.
9. Meter readings and similar recordings.
10. Emergency procedures.
11. Orders and requests of governing authorities.
12. Change Orders received, implemented.
13. Services connected, disconnected.
14. Equipment or system tests and start-ups.
15. Partial completions, occupancies.
16. Substantial completions authorized.

2. Material Location Reports. At monthly intervals prepare a comprehensive list of materials delivered to and stored at the site. The list shall be cumulative, showing materials previously reported plus items recently delivered. Include with the list a statement of progress on and delivery dates for all materials or items of equipment being fabricated or stored away from the building site. Submit copies of the list to the Engineer at monthly intervals.

3. Field Correction Report. When the need to take corrective action that requires a departure from the Contract Documents arises, prepare a detailed report including a statement describing the problem and recommended changes. Indicate reasons the Contract Documents cannot be followed. Submit a copy to the Engineer immediately.

4. Spare Parts Inventory Report. Document in writing on forms provided by the Engineer delivery to the Owner of specified spare parts. Include the manufacturer's name, part name, number, and quantity delivered. Reports shall be signed by representatives of the Contractor, Owner, and Engineer. Reports are due prior to substantial completion.

H. EQUIPMENT START-UP REPORT AND CERTIFICATION

1. An experienced, authorized service representative (not a sales representative) of the manufacturer of each item of equipment shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment manufacturer's representative shall be present when the equipment is placed in operation and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of the Engineer.

2. Each equipment manufacturer's representative shall furnish to the Owner, through the Engineer, a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and (4) has been operated under full load conditions and that it operated satisfactorily. Work will not be accepted as substantially complete until executed Equipment Start-up Report and certification forms have been submitted in accordance with the requirements of this section.

3. Properly coordinate the visits by the manufacturer's representatives, particularly where the operation of an item of equipment is dependent on the operation of other equipment. Prior to calling the manufacturer's representative, ensure that all necessary related equipment, structures, piping, and electrical work is complete. Pay for any revisits to the site by the manufacturer's representative made necessary due to the Contractor's failure to properly coordinate the visits.

4. Secure the services of the manufacturer's representative at the site of the work for as long as is necessary to check the installation and place the equipment in satisfactory operation.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

A. PAYMENT

1. No requests for payment for work under this Contract will be processed until the Contractor's Preliminary Construction Schedule, Submittals Tabulation, and Schedule of Values are submitted in conformance with the requirements of this section.

2. FOR LUMP SUM PROJECTS: Schedule of Values are submitted and found acceptable by the Owner and Engineer in conformance with the requirements of this section.

3. No further requests for payment will be processed after the due date of the Contractor's Construction Schedule and Submittal Schedule until both schedules are submitted in conformance with the requirements of this section.

4. If payment is being requested for stored materials, the material location report must be included with the request for payment.

PART 4- PAYMENT

All schedule and report requirements shall be covered under the lump sum contract amount.

END OF SECTION 01310

SECTION 01340 -SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

PART 1 – GENERAL

A. SUMMARY

1. This section specifies administrative and procedural requirements for submittal of shop drawings, product data, and samples to verify that products, materials, and systems proposed for use comply with provisions of the Contract Documents.

2. Shop drawings are required for all materials, products, and equipment furnished on this project, unless otherwise specified.

3. Standard information prepared without specific reference to the project is not considered to be shop drawings.

4. Coordination drawings are a special type of shop drawing that show the relationship and integration of different construction elements that require close and careful coordination during fabrication or during installation to fit in the restricted space provided or to function as intended.

5. Product data include, but are not limited to, the following:

    1. Manufacturer's product specifications.
    2. Manufacturer's installation instructions.
    3. Standard color charts.
    4. Catalog cuts.
    5. Roughing-in diagrams and templates.
    6. Standard wiring diagrams.
    7. Printed performance curves.
    8. Operational range diagrams.
    9. Mill reports.
    10. Standard product operating and maintenance manuals.

6. Samples include, but are not limited to, the following:

    1. Partial sections of manufactured or fabricated components.
    2. Small cuts or containers of materials.
    3. Complete units of repetitively used materials.
    4. Swatches showing color, texture, and pattern.
    5. Color range sets.
    6. Components used for independent inspection and testing.

7. Administrative Submittals. Refer to other Division 1 sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to:
    1. Permits
    2. Applications for payment.
    3. Performance and payment bonds.

4. Insurance certificates.
5. Listing of subcontractors.

B. RELATED DOCUMENTS

1. Drawings and general provisions of Contract, including General and Supplemental Conditions or General Provisions and other Division 1 specification sections, apply to this section.

C. CONTRACTOR'S RESPONSIBILITY

1. It is the duty of the Contractor to check all drawings, data, and samples prepared by or for him before submitting them to the Engineer for review. Each and every copy of the Drawings and data shall bear Contractor's stamp showing that they have been so checked. Shop drawings submitted to the Engineer without the Contractor's stamp will be returned to the Contractor for conformance with this requirement. Shop drawings shall indicate any deviations in the submittal from requirements of the Contract Documents.

2. The Contractor shall determine and verify:

    1. Field measurements.
    2. Field construction criteria.
    3. Catalog numbers and similar data.
    4. Conformance with Specifications.

3. Do not begin any of the work covered by a drawing, data, or a sample returned for correction until a revision or correction thereof has been reviewed and accepted by the Engineer.

4. Submit to the Engineer all drawings and schedules sufficiently in advance of construction requirements to provide no less than 21 calendar days for checking and appropriate action from the time the Engineer receives them.

5. Submit four copies for the Engineer plus the number of copies the Contractor requires of descriptive or product data submittals to complement shop drawings (up to a maximum of eight copies). The Engineer will retain four sets. The Engineer will review the blueprints and return to the Contractor the set of marked-up prints with appropriate review comments.

6. Contractor shall be responsible for and bear all cost of damages which may result from the ordering of any material or from proceeding with any part of the work prior to the review by Engineer of the necessary shop drawings.

D. ENGINEER'S REVIEW OF SHOP DRAWINGS

1. The Engineer's review of drawings, data, and samples submitted by the Contractor is for general conformance with the design concept of the project and for general compliance with the information given in the Contract Documents. The Engineer's review and exception, if any, will not constitute an approval of

dimensions, quantities, and details of the material, equipment, device, or item shown.

2. The review of drawings and schedules shall not be construed:

    1. As permitting any departure from the Contract requirements;

    2. As relieving the Contractor of responsibility for any errors, including details, dimensions, and materials;

    3. As approving departures from details furnished by the Engineer, except as otherwise provided herein.

3. If the drawings or schedules as submitted describe variations and show a departure from the Contract requirements which the Engineer finds to be in the interest of the Owner and to be so minor as not to involve a change in contract price or time for performance, the Engineer may return the reviewed drawings without noting an exception.

4. When reviewed by the Engineer, each of the shop drawings will be identified as having received such review, being so stamped and dated. Shop drawings stamped "REVISE AND RESUBMIT" and with required corrections shown will be returned to the Contractor for correction and resubmittal.

5. Resubmittals will be handled in the same manner as first submittals. On resubmittals the Contractor shall direct specific attention, in writing or on resubmitted shop drawings, to revisions other than the corrections requested by the Engineer on previous submissions. Make any corrections required by the Engineer.

6. If the Contractor considers any correction indicated on the Drawings to constitute a change to the Contract Drawings or Specifications, the Contractor shall give written notice thereof to the Engineer.

7. The Engineer will review a submittal/resubmittal a maximum of 3 times, after which the cost of review will be borne by the Contractor. The cost of engineering will be equal to the Engineer's charges to the Owner under the terms of the Engineer's agreement with the Owner.

8. When the shop drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Engineer.

9. No partial submittals will be reviewed. Submittals not complete will be returned to the Contractor and will be considered "Rejected" until resubmitted.

E. SUBMITTAL PROCEDURES

1. Coordination. Coordinate preparation and processing of submittals with performance of the work. Transmit each submittal to the Engineer sufficiently in

advance of scheduled performance of related construction activities to avoid delay.

1. Coordinate each submittal with other submittals and related activities that require sequential activity including:

    1. Testing.
    2. Purchasing.
    3. Fabrication.
    4. Delivery.

2. Coordinate transmittal of different types of submittals for the same element of the work and different elements of related parts of the work so that processing will not be delayed by the Engineer's need to review submittals concurrently for coordination.

    1. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are forthcoming.

    2. No extension of time will be authorized because of the Contractor's failure to transmit submittals to the Engineer sufficiently in advance of the work to permit processing.

2. Submittal Preparation. Prepare and submit shop drawings in accordance with the following:

    1. Attach a submittal cover sheet to each copy of a shop drawing. The submittal cover sheet shall contain the following information:

        1. Project name and Owner’s name.
        2. Contractor’s name and address.
        3. Engineer’s name and address.
        4. Specification section and title.
        5. Drawing reference number.
        6. Submittal number.
        7. Space to indicate the results of the Contractor’s review.
        8. Space to indicate any deviations from the Contract Documents or comments by the Contractor.
        9. Space approximately 8 inches wide and 4 inches high for the Engineer to indicate the results of his review and any comments.

    2. Each shop drawing submittal shall be assigned a sequential number, beginning with the number 1. Resubmittals shall be identified by a letter suffix (i.e., 1A, 1B, etc.).

    3. Submittal Transmittal. Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer, and to other destinations, as indicated, by use of a transmittal form. Submittals received from sources other than the Contractor will be returned to the

sender without action. A separate transmittal shall be used for each shop drawing submittal.

F. SHOP DRAWINGS

1. The term "shop drawings," when used in the Contract Documents, shall be considered to mean Contractor's plans for material and equipment which become an integral part of the Project. These drawings shall be complete and detailed. Shop drawings shall consist of fabrication, erection and setting drawings and schedule drawings, manufacturer's scale drawings, and wiring and control diagrams. Cuts, catalogs, pamphlets, descriptive literature, and performance and test data shall be considered only as support to required shop drawings as defined above.

2. Drawings and schedules shall be checked and coordinated with the work of all trades involved before they are submitted for review by the Engineer. Contractor shall indicate whether the shop drawing complies with or deviates from the requirement of the Contract Documents.

3. If drawings show deviations from Contract requirements because of standard shop practice or for other reasons, the Contractor shall clearly mark and describe such deviation in his letter of transmittal. If the Contractor fails to describe such variations, he shall not be relieved of the responsibility for executing the Work in accordance with the Contract, even though such drawings have been reviewed.

4. Data on materials and equipment include, without limitation, materials and equipment lists, catalog data sheets, cuts, performance curves, diagrams, materials of construction and similar descriptive material. Materials and equipment lists shall give, for each item thereon, the name and location of the supplier or manufacturer, trade name, catalog reference, size, finish and all other pertinent data.

5. Installation List. All manufacturers or equipment suppliers who propose to furnish equipment or products under Divisions 11, 15, and 16 shall submit an installation list to the Engineer along with the required shop drawings. The installation list shall include at least five installations where identical equipment has been installed and has been in operation for a period of at least 1 year.

6. Color. Only the Engineer will utilize the color "red" in marking shop drawing submittals.

7. Before final payment is made, the Contractor shall furnish to Engineer five sets of record drawings, all clearly revised, complete and up to date showing the permanent construction as actually made for all reinforcing and structural steel, miscellaneous metals, process and mechanical equipment, yard piping, electrical system and instrument system.

G. SAMPLES

1. Furnish, for the approval of the Engineer, samples required by the Contract Documents or requested by the Engineer. Samples shall be delivered to the Engineer as specified or directed. The Contractor shall prepay all shipping charges on samples. Materials or equipment for which samples are required shall not be used in work until approved by the Engineer.

H. SPECIFIC SUBMITTAL REQUIREMENTS

1. Submit coordination drawings where required for integration of different construction elements. Show construction sequences and relationships of separate components where necessary to avoid conflicts in utilization of the space available.

2. Highlight, encircle, or otherwise indicate deviations from the Contract Documents on the shop drawings.

3. Do not permit shop drawing copies without an appropriate final stamp or other marking indicating the action taken by the Engineer to be used in connection with construction.

4. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit shop drawings on sheets at least 82 by 11 inches but no larger than 30 by 40 inches.

I. PRODUCT DATA

1. Collect product data into a single submittal for each element of construction or system. Mark each copy to show which choices and options are applicable to the Project.

2. Where product data have been printed to include information on several similar products, some of which are not required for use on the project, or are not included in this submittal, mark copies to clearly indicate which information is applicable.

3. Where product data must be specially prepared for required products, materials, or systems, because standard printed data are not suitable for use, submit as "shop drawings," not "product data."

4. Include the following information in product data:

    1. Manufacturer's printed recommendations.
    2. Compliance with recognized trade association standards.
    3. Compliance with recognized testing agency standards.
    4. Application of testing agency labels and seals.
    5. Notation of dimensions verified by field measurement.
    6. Notation of coordination requirements in submittals. Submit two copies of each required product data submittal; submit two additional copies where copies are required for maintenance manuals. The Engineer will retain one copy and will return the other marked with the action taken and corrections or modifications required.

5. Distribution. Furnish copies of final product data submittal to manufacturers, subcontractors, suppliers, fabricators, installers, governing authorities and others as required for performance of the construction activities. Show distribution on transmittal forms.

    1. Do not proceed with installation of materials, products and systems until a copy of product data applicable to the installation is in the installer's possession.

    2. Do not permit use of unmarked copies of project data in connection with construction.

J. ENGINEER'S ACTION

1. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:

    1. Final Unrestricted Release: Where submittals are marked APPROVED AS SUBMITTED," that part of the work covered by the submittal may proceed, provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.

    2. Final-But-Restricted Release: When submittals are marked "APPROVED AS NOTED," that part of the work covered by the submittal may proceed, provided it complies with both the Engineer's notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.

    3. Returned for Resubmittal: When submittal is marked "RETURNED FOR CORRECTIONS," do not proceed with that part of the work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the Engineer's notations; resubmit without delay. Repeat if necessary, to obtain a different action mark.

        1. Do not permit submittals marked "RETURNED FOR CORRECTIONS" to be used at the project site, or elsewhere where construction is in progress.

    4. Rejected: When submittal is marked "REJECTED," the materials, equipment, and/or methods identified in the submittal do not comply with the Contract requirements and shall not be incorporated into the work. No resubmittal of the same materials, equipment, and/or methods shall be made.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

PART 4- PAYMENT

All services associated with the above section shall be covered under the lump sump contract amount.

END OF SECTION 01340

SECTION 02110 - SITE CLEARING

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

DESCRIPTION OF WORK:

Extent of site clearing is shown on drawings.

Site clearing work includes, but is not limited to:

Removal of trees and other vegetation.

Topsoil stripping.

Clearing and grubbing.

Equipment/structures/utilities removal where noted on the plans

JOB CONDITIONS:

Traffic: Conduct site clearing operations to ensure minimum interference with roads, streets, and other adjacent occupied or used facilities. Do not close or obstruct streets or other occupied or used facilities without permission from authorities having jurisdiction.

Protection of Existing Improvements: Provide protections necessary to prevent damage to existing improvements indicated to remain in place.

Protect improvements on adjoining properties and on Owner's property.

Restore damaged improvements to their original condition, as acceptable to parties having jurisdiction.

PART 2 - PRODUCTS

Not applicable to work of this section.

PART 3 - EXECUTION

SITE CLEARING:

General: Remove trees, shrubs, grass and other vegetation, improvements, or obstructions interfering with installation of new construction. Remove such items elsewhere on site or premises as specifically indicated. Removal includes digging out stumps and roots.

Topsoil: Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4". Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other object over 2" in diameter, and without weeds, roots, and other objectionable material.

Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material.

Remove heavy growths of grass from areas before stripping.

Stockpile topsoil in storage piles in areas as directed. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent wind-blown dust.

DISPOSAL OF WASTE MATERIALS:

Disposal of waste is the responsibility of the Contractor (unless otherwise noted) and shall be done following all applicable rules and regulations. Equipment and other items removed shall become property of the Owner where noted on the plans and specifications.

PART 4- PAYMENT

All site clearing services shall be paid under the lump sum amount of the contract.

END OF SECTION 02110

SECTION 02200 - EARTHWORK

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Site layout work.

B. Perform mass excavation, trench excavation, and embankment as shown on the drawings. Utilize fill material for proposed site grading from designated areas noted on the plans or otherwise approved by Engineer and Owner.

C. All excavation for this project shall be considered unclassified. This includes all grade work, pipe culvert excavation, ditching, and drainage structure excavation.

D. Fine grade for pavement areas.

E. Furnish, spread, and fine grade of topsoil over all areas to be landscaped.

1.2 RELATED WORK:

1.3 ELEVATIONS AND GRADES:

A. Elevations and grade lines shown on the drawings indicate the height in relation to benchmarks noted on the drawings.

B. The words "finished grades" as used herein means the required final grade elevations indicated on the drawings. Should finished grades shown by spot elevations conflict with those shown by contours, such discrepancies shall be referred to the Engineer for adjustment before any work affected thereby is performed.

1.4 PROTECTION:

A. The Contractor shall assume responsibility for protection of benchmarks, property corners, and other reference points. The Contractor shall replace, as directed, any reference points removed or destroyed during construction.

B. The Contractor shall assume responsibility for protection of public roads, curbs, and utilities from damage from the Contractor's operations. Plan work to avoid ponding, flooding, and washing on site and upon adjacent property.

C. Meet the requirements of all rules and regulations governing the respective utilities. Protect active utilities from damage during construction.

D. Provide, set, and remove all bracing, shoring, and sheet piling required to prevent cave-ins.

E. Provide and maintain all pumping facilities required to keep excavations free of water. Water shall not be conducted onto adjacent property.

1.5 PROJECT RECORD DOCUMENTS:

A. Accurately record location of utilities remaining, rerouted utilities, new utilities by horizontal dimensions, elevations or inverts, and slope gradients.

1.6 TESTS:

A. Maximum density and optimum moisture are to be determined in accordance with ASTM D-698 (Standard Proctor).

B. Each layer of embankment shall be compacted to required density and approved before material for the next succeeding layer is placed. Placing and compacting areas shall be kept separate. A minimum of 2 density tests per layer are required at locations selected by the Engineer. The determination of the density of the soil in place will be in accordance with an approved method. All soil tests, including the Standard Proctor and the density tests required per embankment layer shall be done by an independent testing laboratory hired by the contractor. The name of the lab to be used is to be submitted prior to any soil work for approval by the Engineer.

C. When a minimum of 95% of maximum density is required, the moisture content of the material being compacted shall meet both the following conditions: (1) The moisture content shall be within the range of values at which 95% of the maximum density can be obtained as indicated by the moisture-density relationship curve and (2) The moisture content shall not exceed the optimum moisture content to the extent that the material pumps under loads applied by the construction equipment.

D. When 100% of maximum density is required, the moisture content of the material being compacted shall meet condition (2) above and shall not vary from the optimum moisture content by more than plus or minus three percentage points.

E. Density of materials shall be as specified in the Soils Report (Geotechnical Report), if available.

PART 2 - EXECUTION

2.1 SOILS REPORT:

A. All undercutting, excavation, filling, foundation preparation, and grading shall be done per recommendations of the report.
B. A Soils Report is included with these documents.

2.2 REMOVAL OF STRUCTURES & OBSTRUCTIONS:

A. This work consists of the removal of all buildings, fences, structures, pavements, pipelines and any other obstructions which are not to remain on the site. It shall also include the salvaging of designated materials and backfilling the remaining trenches and holes

B. Unless otherwise noted on the plans, all materials from such removed obstructions shall become the property of the Contractor and shall be disposed of outside the project site. If the material is disposed of on private property, the Contractor shall secure written permission from the property owner(s) and furnish the Engineer with a copy of the agreement(s).

2.3 PREPARATION:

1. Identify required lines, levels, contours and datum.

2. Identify known below grade utilities. Stake and flag locations.

3. Identify and flag above grade utilities.

4. Maintain and protect existing utilities remaining which pass through work area.

5. Notify utility companies to remove and relocate utilities if required to perform the intended work.

6. Upon discovery of unknown utility or concealed conditions, discontinue affected work; notify Engineer.

2.4 CLEARING & GRUBBING:

A. This work shall consist of clearing, grubbing, removal and disposal of all vegetation and debris within the limits off the site except objects designated to remain. This work shall also include the preservation from injury or defacement of all objects designated to remain. The site shall be stripped and all deleterious material (brush, grass, topsoil, etc.) shall be removed.

B. All trees, stumps, brush, projecting roots, hedge, weeds, fences, logs and other protruding obstructions on the site shall be cleared.

C. Within the areas where embankments are to be constructed, all depressions resulting from grubbing operations shall be backfilled with suitable excavation material and compacted in accordance with this section.

D. If perishable material is burned, it shall be burned under constant care and in accordance with any applicable laws and ordinances. Material removed from the site shall be disposed after the Contractor has secured permission from the owner.

2.5 EXCAVATION:

A. Prior to beginning excavation, grading, and embankment operations in any area, all necessary clearing and grubbing and removal of structures and obstructions shall be performed.

B. Excavation materials shall be removed in such a manner that the slopes may be neatly trimmed to lines given.

C. If more material is required to complete the embankments after all cuts have been brought to grade and all roads and drainage excavation has been removed, additional materials shall be obtained by the Contractor. It shall not be obtained from other areas of the site unless directed by the Engineer.

D. All suitable materials removed from the excavation areas shall be used in the construction of embankments, road approaches, and in such other places as directed by the Engineer.

E. When boulder formations occur, the excavation area shall be scarified, and all boulders removed to a depth of twelve inches below grade. The cavities thus formed shall be backfilled with suitable material and compacted.

F. All loose rock on cut slopes shall be removed immediately.

G. When the Contractor's excavating operations encounter remains of prehistoric people's dwelling sites or artifacts or historical of archaeological significance, the operations shall be temporarily discontinued. The Designer will contact archaeological authorities to determine the disposition thereof.

H. The Designer shall designate as unsuitable those soils that cannot be properly compacted in embankments. All unsuitable soil shall be removed from the site by the Contractor and disposed of at location obtained by the Contractor.

2.6 UNDERCUTTING:

A. This work shall consist of the removal and disposal of unsatisfactory materials below grade in cut sections, and the removal and disposal of unsatisfactory material from areas upon which embankments are to be placed. It shall also include undercutting for pipe where required.

B. Undercutting does not include the stripping, stockpiling and placing of topsoil; neither does it include step benching in the preparation of embankment areas on hillsides.

2.7 STRIPPING, STOCKPILING AND PLACING TOPSOIL:

A. The Engineer will designate areas between slope stake points in both cut and fill from which the existing topsoil shall be stripped.

B. The Engineer will designate areas to be deleted from stripping operations because of rock or other unsuitable material.

C. A four to six-inch layer of topsoil shall be placed on all areas to be reseeded unless otherwise directed by Engineer.

2.8 SLOPING, SHAPING AND DRESSING:

A. The slopes of all excavated areas, ditches, waterways, channels, borrow pits and embankments shall be so trimmed and shaped as to be in reasonably close conformity with the cross sections shown on the plans or as directed by the Designer.

2.9 EMBANKMENTS:

A. This work shall consist of constructing embankments, including preparation of the area upon which they are to be placed; the placing and compacting of approved material within areas where unsuitable material has been removed; and the placing and compacting of embankment material in holes, pits, and other depressions all in accordance with these specifications and reasonably close conformity with the lines, grades, and typical cross sections shown on the plans or established by the Designer. Only approved material shall be used in the construction of embankments and backfills.

B. Before embankment construction in any area is begun, clearing and grubbing, and removal of structures and obstructions shall have been performed.

C. The original ground surface, or the surface of any embankment layer in place, shall not be in frozen condition, and shall be free from quantities of snow, ice and mud when a subsequent layer is placed thereon.

D. All depressions or holes below the natural ground surface, whether caused by grubbing or otherwise, shall be filled with suitable material and compacted to ground surface before embankment construction is started.

E. Any area requiring fill to achieve final grade shall be proof rolled with pneumatic tire equipment having a static weight of at least ten (10) tons. The proof-rolling operations shall be observed by the Designer and any areas which rut excessively or fail to tighten shall be undercut to firm soil (or a maximum depth of 3 feet) and replaced with select structural fill.

F. Unless shown otherwise on the plans or in the Special Provisions, where embankment of less than three feet is to be made, the cleared surface shall be completely broken up by plowing, scarifying or stepping to a minimum depth of six inches. This area shall

then be re-compacted.

G. When the embankment is to be placed and compacted on hillsides, or when the embankment is to be built one-half width at the time, the slopes that are steeper than 4:1 shall be continuously benched over those areas as the work is brought up in layers. Benching shall be of enough width to permit the operation of placing and compacting equipment. Each successive cut shall begin at the intersection of the original ground and the vertical side of the previous cut.

H. Material thus cut shall be re-compacted along with the new embankment material at the Contractor's expense.

I. Backfilling around a structure, or any unit thereof, shall have been completed and thoroughly compacted to ground surface before any embankment materials are placed thereon.

J. Perishable materials, such as brush, hedge, roots, stumps, parts of trees, etc. shall not be incorporated or buried in the embankment.

K. Embankment shall be so constructed that adequate surface drainage will always be provided . Embankment materials that consist predominantly of soil shall be placed in horizontal layers not to exceed ten inches in depth before compaction.

L. Each layer shall be compacted to a density recommended in the Soils Report.

M. The Contractor shall aerate the material or distribute and incorporate water uniformly therein, as necessary, to control the moisture content within the applicable limits set out above.

2.10 FOUNDATION PREPARATION AND BACKFILL:

A. Foundation preparation shall consist of necessary excavating, removal, stockpiling and satisfactory disposal of all material within the limits of the foundation excavation.

B. The instructions and guidelines outlined in the Geotechnical Report shall be followed. For all other proposed structures not covered in the Geotechnical Report, the Contractor shall comply with items i or ii below:

1. When rock, hardpan or other unyielding material, is encountered in the excavation, it shall be removed below the foundation grade for a depth of six inches, or as directed by the Designer. Excavation shall be brought back up to grade by placement of suitably graded soil (compact 100%), sand, or crushed stone (compact to 75% of loose volume).
2. In all other areas undercut 12” below the footing/slab elevation and replace with compacted (100%) crushed stone.

C. All suitable excavated materials shall be utilized as backfill or embankment. Material for backfill shall be fine compactible soil selected from structure excavation if approved by the Designer as being suitable. Backfill material adjacent to underground concrete structures shall consist of #67 stone backfill extending two (2) feet from the proposed structure or as shown on the Construction Drawings. Backfill material shall be compacted per the Soils Report. In lieu of the 2'-0" stone backfill, prefabricated drainage composite system such as Miradrain, or equal may be used.

D. Final dressing shall be performed by hand work and machines to produce a uniform satisfactory finish to all parts of the roadway and embankments. The building site, roadbed, shoulders, ditches and slopes shall be shaped within reasonably close conformity to the specified lines, grades and cross sections. Rock cuts shall be scaled of all loose fragments and left in a neat safe and workmanlike condition.

E. The entire site shall be cleaned of all weeds, briars, and bushes. All structures, both old and new, shall be cleared and cleaned of all brush, drifts, heavy vegetation, sediment, rubbish, obstructions and other objectionable material.

F. Final dressing shall be performed prior to sodding and seeding operations.

PART 3 - PAYMENT

A. Earthwork will not be considered for direct payment but shall be part of the lump sum price bid.

END OF SECTION 02200

SECTION 02260 - SLOPE PROTECTION AND EROSION CONTROL

PART 1 - GENERAL

DESCRIPTION:

This Section shall consist of temporary control measures as shown in the Construction and Erosion Control Plans or directed by the Engineer during the life of the Contract to control erosion and water pollution through the use of berms, dikes, dams, sediment basins, fiber mats, netting, mulches, grasses, slope drains, temporary silt fences, and other control devices.

The temporary pollution control provisions contained herein shall be coordinated with the permanent erosion control features, to assure economical, effective, and continuous erosion control throughout the construction and post-construction period.

Prior to initiation of construction, the Contractor shall review the latest applicable soil erosion and control rules and regulations and take actions necessary to comply with the Division of Water requirements.

GENERAL CRITERIA:

Stabilization of Denuded Areas and Soil Stockpiles:

Permanent or temporary soil stabilization must be applied to denuded areas within 15 days after final grade is reached on any portion of the site. Soil stabilization must also be applied within 15 days to denuded areas which may not be at final grade but will remain dormant (undisturbed for longer than 30 days.

> Soil stabilization refers to measures which protect soil from the erosive forces of raindrop impact and flowing water. Applicable practices include vegetative establishment, mulching, and the early application of gravel base on areas to be paved. Soil stabilization measures should be selected to be appropriate for the time of year, site conditions, and estimated duration of use.

Soil stockpiles must be stabilized or protected with sediment trapping measures to prevent soil loss.

Establishment of Permanent Vegetation:

A permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. Permanent vegetation shall not be considered established until a ground cover is achieved which, in the opinion of the Engineer or his designated agent, is mature enough to control soil erosion satisfactorily and to survive severe weather conditions.

Protection of Adjacent Properties:

Properties adjacent to the site of a land disturbance shall be protected from sediment deposition. This may be accomplished by preserving a well-vegetated buffer strip around the lower perimeter of the land disturbance, by install perimeter controls such as sediment basins, or by a combination of such measures.

Vegetated buffer strips may be used alone only where runoff in sheet flow is expected. Buffer strips should be at least 20 feet in width. If at any time it is found that a vegetated buffer strip alone is ineffective in stopping sediment movement onto adjacent property, additional perimeter controls must be provided.

Timing and Stabilization of Sediment Trapping Measures:

Sediment basins and traps, perimeter dikes, sediment barriers and other measures intended to trap sediment on-site must be constructed as a first step in grading and be made functional before upslope and land disturbance takes place. Earthen structures such as dams, dikes, and diversions must be seeded and mulched within 15 days of installation.

Sediment Basins:

Stormwater runoff from drainage areas with five acres or greater disturbed area must pass through a Sediment Basin or other suitable sediment trapping facility with equivalent or greater storage capacity. The Engineer may require sediment basins or traps for smaller disturbed areas where deemed necessary. The sediment basin requirement may also be waived, by variance, if the Engineer agrees in writing that site conditions do not warrant its construction.

Cut and Fill Slopes:

Cut and fill slopes must be constructed in a manner which will minimize erosion. Consideration must be given to the length and steepness of the slope, the soil type, upslope drainage area, ground water conditions and other applicable factors. Slopes which are found to be eroding excessively within one year of construction must be provided with additional slope stabilizing measures, as directed by the Engineer, until the problem or problems are corrected.

1. Roughened soil surfaces are generally preferred to smooth surfaces on slopes.

2. Diversions should be constructed at the top of long steep slopes which have significant drainage areas above the slope. Diversions or terraces may also be used to reduce slope length.

3. Concentrated stormwater shall not be allowed to flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume or slope drain structure.

4. A slope face that crosses a water seepage plane which endangers the stability of the slope, adequate drainage or other protection shall be provided.

Stormwater Management Criteria for Controlling Off-Site Erosion:

Properties and waterways downstream from development sites shall be protected from erosion due to increases in the volume, velocity and peak flow rate of stormwater runoff.

To satisfy this requirement, the following criteria shall apply:

Concentrated stormwater runoff leaving a development site must be discharged directly into a well-defined, natural or man-made off-site receiving channel or pipe. If there is no well-defined off-site receiving channel or pipe, one must be constructed to convey stormwater to the nearest adequate channel. Newly constructed channels shall be designed as adequate channels.

An adequate channel shall be defined as a natural or man-made channel or pipe which can convey the runoff from a 10-year storm without overtopping its banks or eroding after development of the site in question. A receiving channel may also be considered adequate at any point where the total contributing drainage area is at least 100 times greater than the drainage area of the development site in questions; or, if it can be shown that the peak rate of runoff from the site for a 10-year storm will not be increased after development.

Runoff rate and channel adequacy must be verified with engineering calculations.

If an existing off-site receiving channel is not an adequate channel, one of the following options shall apply:

Obtain legal permission from all downstream property owners and a permit from the State of Tennessee to improve the receiving channel to an adequate condition. Such improvements shall extend downstream until an adequate channel section is reached.

Develop a site design that will not cause the pre-development peak runoff rate from a 10-year storm to increase. Such a design may be accomplished by enhancing the infiltration capability of the site or by providing on-site stormwater detention measures. The pre-development and post-development peak runoff rates must be verified by engineering calculations.

Provide a combination of channel improvement, stormwater detention, or other measures which is satisfactory to the Engineer to prevent downstream channel erosion.

All channel improvements or modification must comply with all applicable federal, state, and local laws and regulations. Modifications to flowing streams shall be made in accordance with Best Management Practices for Hydrologic Modification.

If the applicant chooses an option which includes stormwater detention, he must provide the Engineer with a plan for maintenance of the detention facilities. The plan shall set forth the maintenance requirements of the facility and party responsible for performing the maintenance.

Increased volumes of unconcentrated sheet flows which will cause erosion or sedimentation on adjacent property must be diverted to a stable outlet or detention facility.

In applying these stormwater management criteria, individual lots in subdivision developments shall not be considered separate development projects, but rather the subdivision development, as a whole, shall be considered a single development project.

Stabilization of Waterways and Outlets:

All on-site stormwater conveyance channels shall be designed and constructed to withstand the expected velocity of flow from a 10-year frequency storm without erosion. Stabilization adequate to prevent erosion must also be provided at the outlets of all pipes and paved channels.

Storm Sewer Inlet Protection:

All storm sewer inlets which are made operable during construction shall be protected so that sediment-laden water will not enter the conveyance system without first being filtered or otherwise treated to remove sediment.

Working In or Crossing Watercourses:

Construction vehicles should be kept out of watercourses to the extent possible. Where in-channel work is necessary, precautions must be taken to stabilize the work area during construction to minimize erosion. The channel (including bed and banks) must always be restabilized immediately after in-channel work is completed. (See separation of pipe utilities and stream crossings standard section.

Where a live (wet) watercourse must be crossed by construction vehicles during construction, a TEMPORARY STREAM CROSSING must be provided.

All federal, state, and local laws and regulations will apply to Temporary Stream Crossing. These shall include, but are not limited to:

a. An Aquatic Resources Alteration Permit from the State of Tennessee

b. Rules and regulations of the U.S. Army Corps of Engineers

Underground Utility Construction Near Streams, Stream Crossings, and General Utility Construction:

The construction of underground utility lines shall be subject to the following criteria:
Best management practices for erosion and sediment controls include construction management measures, vegetative controls, and structural controls. Some control practices can be used independently, others must be in combination. Erosion controls are not restricted to the following practices. However, alternative measures must be at least as effective in controlling erosion and sedimentation.

Construction Management Techniques or Management Measures

1) Utility line crossings shall be constructed perpendicular to or as close to 90 degrees as possible to streams in previously undisturbed areas. Crossing angles other than 90 degrees will be allowed if new lines are constructed parallel to existing.

2) The number of stream crossings shall be minimized.

3) Clearing and grubbing must be held to the minimum necessary for equipment operation.

4) Construction must be sequenced to minimize the exposure time of cleared area. Grading activities must be avoided during months of highly erosive rainfall.

5) Construction must be staged or phased for large projects. Areas of one phase must be stabilized before another phase can be initiated. Stabilization shall be accomplished by temporally or permanently protecting the disturbed soil surface from rainfall impacts and runoff.

6) Erosion and sediment control measures must be in place and functional before earth moving operations begin. All control measures must be properly constructed and maintained throughout the construction period.

7) Regular maintenance is vital to the success of an erosion and sediment control system. Erosion and sediment control measures shall be checked weekly and after each rainfall. During prolonged rainfall, daily checking is necessary.

8) Construction debris must be kept from entering the steam channel.

9) Excavated material from the pipe trench shall not be placed between the trench and the stream. Instead, it shall be placed on the upslope side of the excavation such that any erosion from it is caught by the trench.

10) Trenches or pits shall be promptly backfilled and stabilized to reduce the risk of erosion.

11) A specific individual shall be designed to be responsible for erosion and sediment controls on each project site.

12) The disturbed stream banks at all crossings shall be stabilized within five calendar days of completion of the crossing.

Vegetative Controls:

1) A buffer strip of vegetation at least as wide as the stream must be left along the stream bank whenever possible. On streams less than 15 feet wide, the buffer zone shall extend at least 15 feet back from the water's edge.

2) Unnecessary canopy removal is discouraged. When necessary, trees and shrubs should be cut so that they fall away from the stream.

3) Vegetative ground cover shall not be destroyed, removed, or disturbed more than 15 calendar days prior to grading.

4) Temporary soil stabilization with appropriate annual vegetation shall be applied on areas that will remain unfinished for more than 30 calendar days.

5) Permanent soil stabilization with perennial vegetation shall be applies as soon as possible after final grading.

Structural Controls:

1) Staked and entrenched straw bales and/or silt fence must be installed along the base of all backfills and cuts, on the downhill side of stockpiled soil, and along stream banks in cleared areas to prevent erosion into streams. Silt fence shall not be placed in flowing stream.

2) All surface water flowing toward the construction area shall be diverted around the construction area to reduce its erosion necessary.

3) A floating sediment boom may be placed downstream of the construction area to collect the unsettled silt or debris. This device shall be cleaned and maintained on daily basis.

4) Cofferdams constructed with sandbags, plastic or non-erodible sheeting shall be placed on either side of the proposed line crossing and extended from bank to bank to prevent the flow of water into the construction area. Water pumped from cofferdams or excavation must be held in properly designed settling basins, dewatering pits, or filter basins until it is at least as clear as upstream water before it is discharged into surface water. Water must be discharged through a pipe or lined channel so that the discharge does not cause erosion and sedimentation.

5) Streams shall not be used as transportation routes for equipment. A stabilized pad of clean and properly sized rock must be used for access road construction. Erosion and sediment control measures must be utilized where the stream bank is disturbed.

No more than 500 feet of trench are to be opened at one time.

Where consistent with safety and space considerations, excavated material is to be placed on the uphill side of trenches.

Trench dewatering devices shall discharge in a manner which will not adversely affect flowing streams, drainage systems or off-site property as follows:

Dewatering Pit - A temporary pit approximately 4 feet in diameter at the bottom will be excavated on the downgrade side of the construction site near the proposed manhole or as directed. The pit will be built and maintained to provide a dry work area in the trench during pipe installation and encasement. Since the excavation of the stream crossing is below the creek bottom, it is expected to be muddy and shall be pumped directly into the silt pit where it can be filtered and allowed to flow overland to the stream. During construction, excavation and filling shall be performed in a manner and sequence that will always provide drainage toward the dewatering pit . Under no circumstances shall pipe be laid in water, and no pipe shall be laid when trench conditions or weather are unsuitable for such work.

After construction, the dewatering pit shall be backfilled as directed by the Engineer.

Above Ground Sediment Trap

1) To reduce sediment in runoff, erosion control structures shall be installed promptly during all construction phases.

2) Sediment traps shall be located at least 20 feet from top of bank.

3) To ensure that erosion control structures work properly, it is imperative that sediment be removed; therefore, inspections of maintenance of structures are to be performed on a regular basis.

4) During sediment removal, the contractor shall take care to ensure that structural components of erosion control structures are not damaged and thus made ineffective.

5) Sediment removed from sediment control structures must be placed at a site such that runoff from the site shall not contaminate any water of the state.

6) Upon complete removal of sediment traps, special ditches etc., the area where they were constructed is to be seeded and mulched.

7) Stockpiled topsoil or fill material must be treated so that sediment runoff will not contaminate surrounding areas or enter nearby streams.

8) Water from cofferdams must not be pumped directly into streams.

9) Clearing and grubbing must be held to the minimum width necessary to accommodate slopes; unnecessary canopy removal (trees, shrubs, etc.) is prohibited.

Silt Pit

1) A sedimentation Pit made of silt fence, located in a grassed area near the stream crossing but not closer than 20 feet from the top of the bank shall be constructed to act as sedimentation basin on site. This will filter silt-laden water which will be pumped from the dewatering pit prior to draining into the

mainstream. When the sediment accumulates to one-third of pit capacity, it shall be removed and placed at a site such that runoff from the site shall not contaminate any waters of the state.

Floating Sediment Boom

1) Definition - a floating device anchored at the bottom of the streambed which will be placed downstream of the construction area.

2) Purpose - To collect unsettled silt or debris that has collected in the construction area of the stream.

3) Planning Considerations - Each installation is unique due to specific conditions. The sediment boom should be in place prior to any clearing or construction activities adjacent to the stream.

4) Maintenance - Sediment boom shall be inspected and maintained daily. Sediment booms shall be cleaned by raising the bottom (upstream) end in a manner which will trap the sediment on the filter cloth. The sediment can then be removed from the boom and placed into the silt fence sediment will not be discharged into the stream.

Construction Access Routes:

Whenever construction vehicle access routes intersect paved public road, provision must be made into minimize the transport of sediment (mud) by runoff or vehicle tracking onto the paved surface. Where sediment is transported onto a public road surface, the roads shall be cleaned thoroughly at the end of each day. Sediment shall be removed from roads by shoveling or sweeping and be transported to a sediment-controlled disposal area. Street washing shall be allowed only after sediment is removed in this manner.

Disposal of Temporary Sediment Control Devices:

All temporary erosion and sediment control measures shall be disposed of within 30 days after final site stabilization is achieved or after the temporary measures are no longer needed, unless otherwise authorized by the Engineer. Trapped sediment and other disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation.

Maintenance:

All temporary and permanent erosion and sediment control practices must be maintained and repaired as needed to assure continued performance of their intended function.

PART 2 - MATERIALS:

STRAW BALE BARRIER:

Definition:

A temporary sediment barrier consisting of a row of entrenched and anchored straw bales.

Purpose:

To intercept and detain small amount of sediment from disturbed areas of limited extent in order to prevent sediment from leaving the site.

To decrease the velocity of sheet flows and low to moderate level channel flows.

Conditions Where Practice Applies:

Below disturbed areas subject to sheet and rill erosion.

Where the size of the drainage area is no greater than 1/4 acre per 100 feet of barrier length; the maximum slope length behind the barrier is 100 feet; and the maximum slope gradient behind the barrier is 50 percent (2:1).

In minor swales or ditch lines where the maximum contributing drainage area is no greater than 2 acres.

Where effectiveness is required for less than 3 months.

Under no circumstances should straw bale barriers be constructed in live streams or in swales where there is the possibility of a washout.

Planning Considerations:

Straw bale barriers must not be used in streams and drainageways where high water velocities and volumes will destroy or impair their effectiveness. Improper placement and installation of the barriers, such as staking the bales directly to the ground with no soil seal or entrenchment, allows undercutting and end flow. This results in additions of rather than removal of sediment from runoff waters. Trapping efficiencies of carefully installed straw bale barriers may drop dramatically due to lack of maintenance.

Design Criteria:

A formal design is not required. See standard construction details.

Sheet Flow Applications:

Bales shall be placed in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another.

All bales shall be either wire-bound or string-tied. Straw bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales (in order to prevent deterioration of the bindings).

The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. After the bales are staked and chinked, the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to 4 inches against the uphill side of the barrier.

Each bale shall be securely anchored by at least two stakes or rebar driven through the bale. The first stake in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or rebar shall be driven deep enough into the ground to securely anchor the bales.

The gaps between bales shall be chinked (filled by wedging) with straw to prevent water from escaping between the bales. (Loose straw scattered over the area immediately uphill from a straw bale barrier tends to increase barrier efficiency).

Channel Flow Applications:

Bales shall be placed in a single row, lengthwise, oriented perpendicular to the contour, with ends of adjacent bales tightly abutting one another.

The remaining steps for installing a straw bale barrier for sheet flow applications apply here, with the following addition.

The barrier shall be extended to such a length that the bottoms of the end bales are higher in elevation than the top of the lowest middle bale to assure that sediment-laden runoff will flow either through or over the barrier but not around it.

Maintenance:

Straw bale barriers shall be inspected immediately after each rainfall and at least daily during prolonged rainfall.

Close attention shall be paid to the repair of damaged bales, end runs and undercutting beneath bales.

Necessary repairs to barriers or replacement of bales shall be accomplished promptly.

Sediment deposits must be removed when the level of deposition reaches approximately one-half the height of the barrier.

Any sediment deposits remaining in place after the straw bale barrier is no longer required shall be dressed to conform to the existing grade, prepared, seeded, and or sodded as directed by the Engineer or his agent.

SILT FENCE:

Definition:

Filter Barrier is a temporary sediment barrier consisting of a filter fabric stretched across and attached to supporting posts and entrenched. The silt fence is a temporary linear filter barrier constructed of synthetic filter fabric, posts, and wire fence for support.

Purpose:

To intercept and detain small amounts of sediment from disturbed areas during construction operations in order to prevent sediment from leaving the site.

To decrease the velocity of sheet flows and low-to-moderate level channel flows.

Conditions Where Practice Applies:

Below disturbed areas where erosion would occur in the form of sheet and rill erosion.

Where the size of the drainage area is no more than 1/4 acre per 100 feet of silt fence length; the maximum slope length behind the barrier is 100 feet; and maximum gradient behind the barrier is 50 percent 92:1).

In minor swales or ditch lines where the maximum contributing drainage area is no greater than 2 acres.

Under no circumstances should silt fences be constructed in live streams or in swales or ditch lines where flows are likely to exceed 1 cubic foot per second (cfs).

Planning Considerations:

Silt fences may be preferable to straw barriers in some cases. While the failure rate of silt fences is lower than that of straw barriers, there have been instances in which silt fences were improperly installed. The installation methods outlined here should be followed.

Filter barriers are inexpensive structures composed of burlap or standard weight synthetic filter fabric stapled to wooden stakes. Flow rates through burlap filter barriers are slightly slower and filtering efficiency is significantly higher than for straw bale barriers.

Silt fences composed of a wire support fence and attached synthetic filter fabric slow the flow rate significantly but have a higher filtering efficiency than burlap. Both woven and non-woven synthetic fabrics are commercially available. The woven fabrics generally display higher strength than the non-woven fabrics. When tested under acid and alkaline water conditions, most of the woven fabrics increase in strength. There are a variety of reactions among the non-woven fabrics. The same is true of testing under extensive ultraviolet radiation. Permeability rates vary regardless of fabric type.

Design Criteria:

No formal design is required, see standard details.

Filter barriers shall have an expected usable life of 3 months. They are applicable in ditch lines, around drop inlets, and at temporary locations where continuous construction changes the earth contour and runoff characteristics and where low or moderate flows (not exceeding 1 cfs) are expected.

Silt fences, because they have a much lower permeability than burlap filter barriers, have their applicability limited to situations in which only sheet or overland flows are expected. They normally cannot filter the volumes of water generated by channel flows, and many of the fabrics do not have enough structural strength to support the weight of water ponded behind the fence line. Their expected usable life is 6 months.

Materials:

Synthetic filter fabric shall be a pervious sheet of propylene, nylon, polyester or ethylene yarn and shall be certified by the manufacturer or supplier.

Burlap shall be 7.5-ounce per square yard fabric.

Posts for Silt Fences shall be 3-inch diameter steel with a minimum length of 7 feet. Steel posts shall have projections for fastening wire to them.

Stakes for Filter Barriers shall be 1" x 2" wood (preferred) or equivalent metal with a minimum length of 3 feet.

Wire fence reinforcement for silt fences using standard strength filter cloth shall be a minimum of 42 inches in height, a minimum of 14 gauge and shall have a maximum mesh spacing of 6 inches.

Filter Barrier - This sediment barrier may be constructed using burlap or standard strength synthetic filter fabric. It is designed for low or moderate flows not exceeding 1 cfs.

The height of a filter barrier shall be a minimum of 32 inches.

Burlap or standard strength synthetic filter fabric shall be purchased in a continuous roll and cut to the length of the barrier to avoid the use of joints (and thus improve the strength and efficiency of the barrier).

The stakes shall be spaced a maximum of 3 feet apart at the barrier location and driven securely into the ground (minimum of 8 inches).

A trench shall be excavated approximately 4 inches wide and 4 inches deep along the line of stakes and upslope from the barrier.

The filter material shall be stapled to the wooden stakes, and 8 inches of the fabric shall be extended into the trench. Heavy-duty wire staples (No.9) at least 11/2 inch long shall be used. Filter material shall not be stapled to existing trees.

The trench shall be backfilled, and the soil compacted over the filter material.

If a filter barrier is to be constructed across a ditch line or swale, the barrier shall be of enough length to eliminate an end flow, and the plan configuration shall resemble an arc or horseshoe with the ends-oriented upslope.

Filter barriers shall be removed when they have served their useful purpose, but not before the upslope are has been permanently stabilized.

Filter barriers and silt fences shall be inspected immediately after each rainfall and at least daily during prolonged rainfall.

TEMPORARY DIVERSION DIKE OR BERM:

Definition:

A temporary ridge of compacted soil located at the top of base of a sloping disturbed area.

Purpose:

To divert storm runoff from higher drainage areas away from unprotected slopes to a stabilized outlet.

To divert sediment-laden runoff from a disturbed area to a sediment trapping facility.

Conditions Where Practice Applies:

Wherever stormwater runoff must be temporarily diverted to protect disturbed slopes or retain sediments on site during construction.

Planning Considerations:

A temporary diversion dike is intended to divert overland sheet flow to a stabilized outlet or a sediment trapping facility during establishment of permanent stabilization on sloping disturbed areas. When used at the top of a slope, the structure protects exposed slopes by keeping upland runoff away. When used at the base of a slope, the structure protects adjacent and downstream areas by diverting sediment-laden runoff to a sediment trapping facility.

Design Criteria:

1. No formal design is required. The following criteria shall be met:

   Drainage Area - The maximum allowable drainage area is 5 acres.

   Height - The minimum allowable height measured from the upslope side of the dike is 12 inches.

   Side Slopes - 1.5:1 or flatter. (Minimum base width of 4.5 feet)

   Grade - The channel behind the dike shall have a positive grade to a stabilized outlet. If the channel slope is less than or equal to 2 percent, the channel shall be stabilized.

Outlet:

The diverted runoff, if free of sediment, must be released through a stabilized outlet or channel.

Sediment-laden runoff must be diverted and released through a sediment trapping facility.

Construction Specifications:

Whenever feasible, the dike should be built before construction begins on the project. The dike should be adequately compacted to prevent failure.

Temporary or permanent seeding and mulch shall be applied to the dike within 15 calendar days of construction.

The dike should be located to minimize damages by construction operations and traffic.

Maintenance:

The measure shall be inspected after every storm and repairs made to the dike, flow channel and outlet, as necessary. Approximately once every week whether a storm has occurred or not, the measure shall be inspected, and repairs made if needed. Damages caused by construction traffic or other activity must be repaired before the end of each working day.

DIVERSION:

Definition:

A channel constructed across a slope with a supporting ridge on the lower side.

Purpose:

To reduce slope length and to intercept and divert stormwater runoff to stabilized outlets at non-erosive velocities.

Conditions Where Practice Applies

1. Where runoff from higher areas may damage property, cause erosion, or interfere with the establishment of vegetation on lower areas.

2. Where surface and/or shallow subsurface flow is damaging sloping upland.

3. Where slopes length needs to be reduced to minimize soil loss.

Planning Considerations:

1. Diversions can be useful tools for managing surface water flows and preventing soil erosion. On moderately sloping areas, they may be placed at intervals to trap and divert sheet flow before it has a chance to concentrate and cause rill and gully erosion. They may be placed at the top of cut or fill slopes to keep runoff from upland drainage areas off the slope. They can also be used to protect structures, parking lots, adjacent properties, and other special areas from flooding.

2. Diversions are preferable to other types of man-made stormwater conveyance systems because they more closely simulate natural flow patterns and characteristics. Flow velocities are generally kept to a minimum. When properly coordinated into the landscape design of a site, diversions can be visually pleasing as well as functional.

3. As with any earthen structure, it is very important to establish adequate vegetation as soon as possible after installation. It is equally important to stabilize the drainage area
above the diversion so that sediment will not enter and accumulate in the diversion channel.

Design Criteria:

1. Location

   a. Diversion location shall be determined by considering outlet conditions, topography, land use, soil type, length of slope, seepage planes (where seepage is a problem) and the development layout.

2. Capacity

   a. The diversion channel must have a minimum capacity to carry the runoff expected from a 10-year frequency storm with a freeboard of at least 0.3 foot.

   b. Diversions designed to protect homes, schools, industrial buildings, road, parking lots, and comparable high-risk areas, and those designed to function in connection with other structures, shall have enough capacity to carry peak runoff expected from a storm frequency consistent with the hazard involved.

3. Channel Design - The Diversion channel may be parabolic, trapezoidal or v-shaped.

4. Ridge Design - The supporting ridge cross-section shall meet the following criteria:

   a. The side slopes shall be no steeper than 2:1.

b. The width at the design water elevation shall be a minimum of 4 feet.

c. The minimum freeboard shall be 0.3 foot.

d. The design shall include a 10 percent settlement factor.

5. Outlet - Diversions shall have adequate outlets which will convey concentrated runoff with erosion.

6. Stabilization

a. Unless otherwise stabilized, the ridge and channel shall be seeded and mulched within 15 calendar days of installation.

b. Disturbed areas draining into the diversion shall be seeded and mulched prior to or at the time the diversion is constructed.

Construction Specifications:

1. All trees, brush, stumps, obstructions, and other objectionable material shall be removed and disposed of so as not to interfere with the proper functioning of the diversion.

2. The diversion shall be excavated or shaped to line, grade, and cross-section as required to meet the criteria specified herein, free of irregularities which will impede flow.

3. Fills shall be compacted as needed to prevent unequal settlement that would cause damage in the complete diversion.

4. All earth removed and not needed in construction shall be spread or disposed of so that it will not interfere with the functioning of the diversion.

Maintenance:

Before final stabilization, the diversion should be inspected after every rainfall. Sediment shall be removed from the ditch line and repairs made as necessary. Seeded areas which fail to establish a vegetative cover shall be reseeded as necessary.

TEMPORARY SEDIMENT TRAP:

Definition:

A small temporary ponding area, formed by constructing an earthen embankment with a gravel outlet, across a drainage swale.

Purpose:

To detain sediment-laden runoff from small-disturbed areas long enough to allow most of the sediment to settle out.

Conditions Where Practice Applies:

1. Below drainage areas of 5 acres or less.

2. Where the sediment trap will be used no longer than 18 months. (The maximum useful life is 18 months).

3. The sediment trap may be constructed either independently or in conjunction with a Temporary Diversion Dike.

Planning Considerations:

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 5 acres, refer to Sediment Basins Criteria.

Sediment must be periodically removed from the trap. Plans should detail how this sediment is to be disposed of, such as by use in fill areas on site or by removal to an approved off-site dump.

Sediment traps, along with other perimeter controls, shall be installed before any land disturbance takes place in the drainage area.

Design Criteria:

1. Trap Capacity

   a. The sediment trap must have an initial storage volume of 67 cubic yards per acre of drainage area, measured from the low point of the ground to the crest of the gravel outlet. Sediment should be removed from the basis when the volume is reduced by one-half.

   b. For a natural basin, the volume may be approximated as follows:

      $V = 0.4 \times A \times D$

      where,

      V = the storage volume in $ft._3$
      A = the surface area of the flooded area at the crest of the outlet, in $ft._2$
      D = the maximum depth, measured from the low point in the trap to the crest of the outlet, in ft.

2. Excavation

   If excavation is necessary to attain the required storage volume, side slopes should be no steeper than 2:1

3. Outlet

   The outlet for the sediment trap shall consist of a crushed stone action section of the embankment located at the low point in the basin. The minimum length of the outlet shall be 6 feet times the acreage of the drainage area. The crest of the outlet must be at least 1 foot below the top of the embankment to ensure that the flow will travel over the stone and not the embankment. This outlet shall be constructed of appropriately sized, clean, crushed stone.

4. Embankment Cross-Section
   The maximum height of the sediment trap embankment shall be 5 feet as measured from the low point. Minimum top widths (W) and various embankment heights (H) are shown in the following Figure. Side slopes of the embankment shall be 2:1 or flatter.

5. Removal

   Sediment traps must be removed after the contributing drainage area is stabilized.

Construction Specifications:

1. The area under the embankment shall be cleared, grubbed, and stripped of any vegetation and root mat. To facilitate cleanout, the pool area should be cleared.

2. Fill material for the embankment shall be free of roots or other woody vegetation, organic material, large stones, and other objectionable material. The embankment should be compacted in 8-inch layers by traversing with construction equipment.

3. Construction operations shall be carried out in such a manner that erosion and water pollution are minimized.

4. The structure shall be removed, and the area stabilized when the upslope drainage area has been stabilized.

5. All cut and fill slopes shall be 2:1 or flatter.

Maintenance:

1. Sediment shall be removed, and the trap restored to its original dimension when the sediment has accumulated to 1/2 the design volume of the trap. Sediment removed from the basin shall be deposited in a

suitable area and in such a manner that it will not erode.

2. The structure should be checked regularly to ensure that it is structurally sound and has not been damaged by erosion or construction equipment. The height of the outlet should be checked to ensure that its center is at least one foot below the top of the embankment.

TEMPORARY SEDIMENT BASIN:

Definition:

A temporary basin with a controlled stormwater release structure, formed by constructing an embankment of compacted soil across a drainageway.

Purpose:

To detain sediment-laden runoff from disturbed areas long enough for most of the sediment to settle out.

Conditions Where Practice Applies:

Below disturbed areas greater than 5 acres. There must be enough space and appropriate topography for the construction of a temporary impoundment. These structures are limited to a useful life of 18 months unless they are designed as permanent ponds by a qualified professional engineer.

Planning Considerations:

1. Effectiveness

   Sediment basins are at best only 70-80 percent effective in trapping sediment which flows into them. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc. to reduce the amount of sediment flowing into the basin.

2. Location

   To improve the effectiveness of the basin, it should be located to intercept the largest possible amount of runoff from the disturbed area. The best locations are generally low areas and natural drainageways below disturbed areas. Drainage into the basin can be improved using diversion dikes and ditches. The basin must not be in a live stream but should be located to trap sediment-laden runoff before it enters the stream. The basin should not be located where its failure would result in the loss of life or interruption of the use of service of public utilities or roads.

3. Multiple Use

   Sediment basins may be designed as permanent structures to remain in place after construction is completed. These structures may be desirable for stormwater detention purpose. Wherever these structures are to become permanent, or if they exceed the size limitations of the design criteria, they must be designed as permanent ponds by a qualified professional engineer. Permanent ponds are beyond the scope of these standards and specifications.

Design Criteria:

The design of sediment basins shall be submitted to the Engineer for approval of construction prior to installation.

1. Vegetative Stabilization

   The embankment and emergency spillway of the sediment basin shall be stabilized with temporary vegetation within 15 days of completion of the basin.

2. Erosion and Sediment Control

   The construction of the sediment basin shall be carried out in a manner such that it does not result in any undue sediment problems downstream.

3. Safety

   All state and local requirements shall be met concerning fencing and signs warning the public of the hazards of soft sediment and floodwaters.

Maintenance:

1. The embankment of the basin should be checked regularly to ensure that it is structurally sound and has not been damaged by erosion or construction equipment.

2. The emergency spillway should be checked regularly to ensure that its lining is well established and erosion resistant.

3. The basin should be checked after each runoff-producing rainfall for sediment cleanout. When the sediment reaches the cleanout level, is shall be removed and properly disposed of.

CHECK DAMS:

A. Definition

Small temporary dams constructed across a swale or drainage ditch.

B. Purpose

To reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the swale or ditch. This practice also traps small amount of sediment generated in the ditch itself. However, this is not a sediment trapping practice and should not be used as such.

C. Conditions Where Practice Applies

1. This practice is limited to use in small open channels which drain 10 acres or less. It should not be used in a live stream. Some specific applications include:

   a. Temporary ditches or swales which, because of their short length of service, cannot receive a non-erodible lining but still need some protection to reduce erosion.

   b. Permanent ditches or swales which for some reason cannot receive a permanent non-erodible lining for an extended period.

   c. Either temporary or permanent ditches or swales which need protection during the establishment of grass linings.

D. Planning Considerations

1. Check dams can be constructed of either stone or logs. Log check dams are more economical from the standpoint of material costs, since logs can usually be salvaged from clearing operations. However, log check dams require more time and hand labor to install. Stone for check dams, on the other hand, must generally be purchased. However, this cost is offset somewhat by the ease of installation.

2. If stone check dams are used in grass-lined channels which will be mowed, care should be taken to remove all the stone from the dam when the dam is removed. This should include any stone which has washed downstream.

3. Since log check dams are embedded in the soil, their removal will result in more disturbance of the soil than will removal of stone check dams. Consequently, extra care should be taken to stabilize the area when log dams re used in permanent ditches or swales.

E. Specifications

1. No formal design is required for check dam; however, the following criteria should be adhered to when specifying check dams.

2. The drainage area of the ditch or swale being protected should not exceed 10 acres. The maximum height of the check dam should be 2 feet. The center of the check dam must be at least 6 inches lower than the outer edges. The cross-sections of the dams should be as shown for logs and stone. The maximum spacing between the dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.

3. Stone check dams should be constructed of 2- to 3- inch stone. The stone should be placed according to the configuration shown. Hand or mechanical placement will be necessary to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges.

4. Log check dams should be constructed of 4- to 6- inch logs salvaged from clearing operations on site, if possible. The logs should be embedded into the soil at least 18 inches. The 6-inch lower height required at the center can be achieved either by careful placement of the logs or by cutting the logs after they are in place.

5. Logs and/or brush should be placed on the downstream side of the dam to prevent scour during high flows.

F. Sediment Removal

While this practice is not intended to be used primarily for sediment trapping, some sediment will accumulate behind the check dams. Sediment should be removed from behind the check dams when it has accumulated to one-half of the original height of the dam.

G. Removal

Check dams may be removed when their useful life has been completed. In temporary ditches and swales, check dams should be removed, and the ditch filled in when it is no longer needed. In permanent structures, check dams should be removed when a permanent lining can be installed. In the case of grass-lined ditches, check dams should be removed when the grass has matured sufficiently to protect the ditch or swale. The area beneath the check dams should be seeded and mulched immediately after they are removed.

H. Maintenance

1. Check dams should be monitored for sediment accumulation after each significant rainfall. Sediment should be removed when it reaches one-half of the original height or before.

2. Regular inspections should be made to ensure that the center of the dam is lower than the edges. Erosion caused by high flows around the edges of the dam should be corrected immediately.

RIPRAP:

A. Definition

A permanent, erosion-resistant ground cover of large, loose, angular stone.

B. Purposes

1. To protect the soil surface from the erosive forces of concentrated runoff.

2. To slow the velocity of concentrated runoff while enhancing the potential for infiltration.

3. To stabilize slopes with seepage problems and/or non-cohesive soils.

C. Conditions Where Practice Applies

To soil-water interfaces where the soil conditions, water turbulence and velocity, expected vegetative cover, etc., are such that the soil may erode under the design flow conditions. Riprap may be used, as appropriate, at storm drain outlets, on channel banks and/or bottoms, roadside ditches, drop structures, at the toe of slopes, etc.

D. Design Criteria

1. Riprap at Outlets

The stabilized discharge structure must be provided. Design criteria for sizing the stone and determining the dimensions of riprap pads used at the outlets of drainage structures are contained in the standard details.

2. Riprap for Channel Stabilization

a. The local Division of Water office must be contacted prior to any stream channel disturbance.

b. Riprap for channel stabilization shall be designed to be stable for the condition of bank-full flow in the reach of channel being stabilized. Riprap shall extend up the banks of the channel to a height equal to the maximum depth of flow or to a point where vegetation can be established to adequately protect the channel.

c. The riprap size to be used in a channel bend shall extend upstream from the point of curvature and downstream from the point of tangency a distance of at least 5 times the channel bottom width. The riprap shall extend across the bottom and up both sides of the channel.

d. Where riprap is used only for bank protection and does not extend across the bottom of the channel, riprap shall be keyed into the bottom of the channel to a minimum depth equal to the thickness of the blanket and shall extend across the bottom of the channel the same distance.

3. Riprap for Slope Stabilization

Riprap for slope stabilization shall be designed so that the natural angle of the repose of the stone mixture is grater than the gradient of the slope being stabilized. See standard details for size.

E. Maintenance

Once a riprap installation has been completed, it should require very little maintenance. It should, however, be inspected periodically to determine if high flows have caused scour beneath the riprap or dislodged any of the stone. If repairs are needed, they should be accomplished immediately.

CONSTRUCTION ROAD STABILIZATION:

A. Definition

The temporary stabilization of access roads, subdivision roads, parking areas, and other on-site vehicle transportation routes with stone immediately after grading.

B. Purposes

1. To reduce the erosion of temporary roadbeds by construction traffic during wet weather.
2. To reduce the erosion and therefore regrading of permanent roadbeds between the time of initial grading and final stabilization.

C. Conditions Where Practice Applies

Wherever stone-base roads or parking areas are constructed, whether permanent or temporary, for use by construction traffic.

D. Planning Considerations

1. Areas which are graded for construction vehicle transport and parking purposes are especially susceptible to erosion. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative

stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires which generate significant quantities of sediment that may pollute nearby streams or be transported off site on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

2. Immediate stabilization of such areas with stone may cost money at the onset, but it may save money in the long run by increasing the usefulness of the road during wet weather.

3. Permanent roads and parking areas should be paved as soon as possible after grading. However, it is understandable that funds for this purpose may not be available in the early phases of the development project. As an alternative, the early application of stone may solve potential erosion and stability problems and eliminate later regarding costs. Some of the stone may also remain in place for use as part of the final base course of the road.

E. Specifications

1. Temporary access Roads and Parking Areas

a. Temporary roads shall follow the contour of the natural terrain to the extent possible. Slopes should not exceed 10 percent.

b. Temporary parking areas should be located on naturally flat areas to minimize grading. Grades should be enough to provide the drainage but should not exceed 4 percent.

c. Roadbeds shall be at least 14 feet wide for one-way traffic and 20 feet wide for two-way traffic.

d. All cuts and fills shall be 2:1 or flatter to the extent possible.

e. Drainage ditches shall be provided as needed and shall be designed and constructed to carry anticipated storm flows.

f. The roadbed or parking surface shall be cleared of all vegetation, roots and other objectionable material.

g. A 6-inch course of clean aggregate shall be applied immediately after grading or the completion of utility installation within the right-of-way. Filter fabric may be applied to roadbed for additional stability in accordance with fabric manufacturer's specifications.

F. Gravel Construction Entrance

1. A gravel construction entrance is a pad of crushed stone that reduces the tracking of mud onto a paved street. To construct the pad, place a layer of 2- to 3-inch (5- to 7.6-cm) stone across the full width of the

vehicle ingress and egress area. The stone pad should be a least 50 feet (15m) along and at least 6 inches (15 cm) thick. Additional stone may have to be added periodically to maintain the proper functioning of the pad.

2. If the crushed stone does not adequately remove the mud from vehicle wheels, the wheels should be hosed off before the vehicle enters a public street. The washing should be done on an area covered with crushed stone, and the wastewater should drain to a sediment trap or sediment barrier.

G. Permanent Roads and Parking Areas

Permanent roads and parking areas shall be designed and constructed in accordance with applicable Tennessee Department of Transportation (TDOT) or local criteria except that an initial base course of gravel of at least 6 inches shall be applied immediately following grading.

H. Vegetation

All roadside ditches, cuts, fills and disturbed areas adjacent to parking areas and roads shall be stabilized with appropriate temporary or permanent vegetation according to the applicable standards and specifications contained in this handbook.

I. Both temporary and permanent roads and parking areas may require periodic top dressing with new gravel. Seeded areas adjacent to the roads and parking areas should be checked periodically to ensure that a vigorous stand of vegetation is maintained. Roadside ditches and other drainage structures should be checked regularly to ensure that they do not become clogged with silt or other debris.

TEMPORARY SLOPE DRAINS:

Temporary slope drains consist of stone gutters, fiber mats, plastic sheets, concrete or asphalt gutters, half-round pipe, metal pipe, plastic pipe, flexible rubber, or other materials which can be used as temporary measures to carry water accumulating in the cuts and on the fills down the slopes prior to installation of permanent facilities or growth of adequate ground cover on the slopes.

Fiber matting and plastic sheeting shall not be used on slopes steeper than 4:1 except for short distances of 20 feet or less.

All temporary slope drains shall be adequately anchored to the slope to prevent disruption by the force of the water flowing in the drains. The base for temporary slope drains shall be compacted and concavely formed to channel the water or hold the slope drain in place. The inlet end shall be properly constructed to channel water into the temporary slope drain.

Energy dissipators, sediment basins, or other approved devices shall be constructed at the outlet end of the slope drains to reduce erosion downstream. An ideal dissipator would be dumped rock or a small sediment basin which would slow the water as well as pick up some sediment. All temporary slope drains shall be removed when no longer necessary and the site restored to match the surroundings.

TEMPORARY SEEDING AND MULCHING:

Seeding and mulching shall be performed in accordance with Section 02480-Miscellaneous Seeding.

BRUSH BARRIERS:

Brush barriers shall consist of brush, tree trimmings, shrubs, plants and other approved refuse from the clearing and grubbing operations. The brush barriers shall be constructed approximately parallel to original ground contour. The brush barrier shall be compressed to an approximate height of 3 to 5 feet and approximate width of 5 to 10 feet. The embankment shall not be supported by the construction of brush barriers.

PART 3 - EXECUTION:

PROJECT REVIEW:

It is the responsibility of the Contractor to implement an erosion control plan as approved by the State of Tennessee and meeting all their requirements. Refer to the attached approval letter and details on the Construction Drawings.

PRE-CONSTRUCTION CONFERENCE:

At the pre-construction conference the Contractor shall submit his schedule for accomplishment of temporary and permanent erosion control work, as are applicable for clearing and grubbing, grading, bridges and other structures at watercourses, construction, and paving. He shall also submit his proposed method of erosion control on haul roads and borrow pits and his plan for disposal of waste materials.

CONSTRUCTION REQUIREMENTS:

The Engineer has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, the surface of erodible earth material exposed by excavation, borrow and fill operations and to direct the Contractor to provide immediate, permanent, or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds, or other water impoundment. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, slope drains, and use of temporary mulches, mats, seeding or other control devices or methods as necessary to control erosion. Cut and fill slopes shall be seeded and mulched as the excavation proceeds to the extent directed by the Engineer.

The Contractor shall be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in his accepted schedule. Temporary pollution

control measures shall be used to correct conditions that develop during construction that were not foreseen during the design stage; that are needed prior to installation of permanent pollution control features; or that are needed temporarily to control erosion that develops during normal construction practices but are not associated with permanent control features on the project.

Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise erosion control measure may be required between successive construction stages. Under no conditions shall the surface area of erodible earth material exposed at one time by clearing and grubbing, exceed 750,000 square feet without approval of the Engineer.

The Engineer will limit the area of excavation, borrow, and embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent pollution control measures current in accordance with accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.

The Engineer may increase or decrease the amount of surface area of erodible earth material to be exposed at one time by clearing and grubbing, excavation, borrow and fill operations as determined by his analysis of project conditions.

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

EROSION CONTROL OUTSIDE PROJECT AREA:

Temporary pollution control shall include construction work outside the project area where such work is necessary as a result of construction such as borrow pit operations, haul roads and equipment storage sites. Bid price in such cases shall include all necessary clearing and grubbing, construction incidentals, maintenance, and site restoration when no longer needed.

PART 4 - MEASUREMENT AND PAYMENT:

No separate measurement and payment will be made for this work. It will be considered a subsidiary obligation of the Contractor under the lump sum price bid for project.

END OF SECTION 02260

SECTION 02316 - ASPHALT PAVING

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work specified in this section.

DESCRIPTION OF WORK:

Extent of asphalt paving work is shown on drawings and for replacement of pavement damaged by construction work.

JOB CONDITIONS:

Weather Limitations: Apply prime and tack coats when ambient temperature is above 50° F. (10° C), and when temperature has not been below 35° (1° C) for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.

Construct asphalt surface course only when atmospheric temperature is above 40° F (4° C), and when base is dry. Base course may be placed when air temperature is above 30° F (-1° C) and rising.

Grade Control: Establish and maintain required lines and elevations.

PART 2 - PRODUCTS

MATERIALS:

General: Use Kentucky Department of Transportation's approved materials and gradations:

ASPHALT-AGGREGATE MIXTURE:

Provide asphalt-aggregate mixture as recommended by local paving authorities to suit project conditions.

PART 3 - EXECUTION

SURFACE PREPARATION:

Remove loose material from compacted sub-base surface immediately before applying prime coat.

Proof roll prepared sub-base surface to check for unstable areas and areas requiring additional compaction.

Notify Contractor of unsatisfactory conditions. Do not begin paving work until deficient sub-base areas have been corrected and are ready to receive paving.

Tack Coat: Apply to contact surfaces of previously constructed asphalt or Portland cement concrete and surfaces abutting or projecting into asphalt concrete pavement. Distribute at rate of 0.05 to 0.15 gallon per square yard of surface.

Allow to dry until proper condition to receive paving.

PLACING MIX:

General: Place asphalt concrete mixture on prepared surface, spread and strike-off. Spread mixture at minimum temperature of 225°F (107° C). Place inaccessible and small areas by hand. Place each course to required grade, cross-section and compacted thickness.

Paver Placing: Place in strips not less than 10' wide, unless otherwise acceptable to Engineer. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing surface course.

Joints: Make joints between old and new placements, or between successive day's work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density and smoothness as other sections of asphalt concrete course. Clean contact surfaces and apply tack coat.

ROLLING:

General: Begin rolling when mixture will bear roller weight without excessive displacement

Compact mixture with hot-hand tampers or vibrating plate compactors in areas inaccessible to rollers.

Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.

Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut-out such areas and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness.

Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

END OF SECTION 02316

SECTION 02419 – SELECTIVE DEMOLITION

PART 1 GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

SUMMARY

This Section includes the following:

Demolition and removal of selected portions of building, structure, or equipment.

Demolition and removal of selected site elements.

Salvage of existing items to be reused or recycled.

Related Sections include the following:

Division 1 Section "Summary" for use of premises, and coordination.

Division 2 Section "Cutting and Patching" for cutting and patching procedures.

DEFINITIONS

Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.

Remove and Salvage: Detach items from existing construction and deliver them to Owner.

Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

SUBMITTALS

Qualification Data: For professional engineer.

Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.

QUALITY ASSURANCE

Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

Standards: Comply with ANSI A10.6 and NFPA 241.

Pre-demolition Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

Pre-demolition Conference: Conduct conference at Project site to comply with requirements in Division 1 Review methods and procedures related to selective demolition including, but not limited to, the following:

Inspect and discuss condition of construction to be selectively demolished.

Review structural load limitations of existing structure.

Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.

Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

Review areas where existing construction is to remain and requires protection.

PROJECT CONDITIONS

Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

Storage or sale of removed items or materials on-site is not permitted.

Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

Maintain fire-protection facilities in service during selective demolition operations.

P2 PRODUCTS (Not Used)

PART 3 EXECUTION

EXAMINATION

Verify that utilities have been disconnected and capped.

Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

Comply with requirements for existing services/systems interruptions specified in Division 1 Section "Summary."

Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

Owner will arrange to shut off indicated services/systems when requested by Contractor.

If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

Where entire wall is to be removed, existing services/systems may be removed with removal of the wall.

PREPARATION

Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.

Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.

Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

Cover and protect furniture, furnishings, and equipment that have not been removed.

Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Division 1 Section "Temporary Facilities and Controls."

Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

Strengthen or add new supports when required during progress of selective demolition.

SELECTIVE DEMOLITION, GENERAL

General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.

Maintain adequate ventilation when using cutting torches.

Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

Dispose of demolished items and materials promptly.

Removed and Salvaged Items:

Clean salvaged items.

Pack or crate items after cleaning. Identify contents of containers.

Store items in a secure area until delivery to Owner.

Transport items to Owner's storage area designated by Owner.

Protect items from damage during transport and storage.

Removed and Reinstalled Items:

Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.

Pack or crate items after cleaning and repairing. Identify contents of containers.

Protect items from damage during transport and storage.

Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

DISPOSAL OF DEMOLISHED MATERIALS

General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

Do not allow demolished materials to accumulate on-site.

Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

Burning: Do not burn demolished materials.

Disposal: Transport demolished materials off Owner's property and legally dispose of them.

REPAIRS

General: Promptly repair damage to adjacent construction caused by building demolition operations.

Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.

Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.

CLEANING

Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

PART 4- PAYMENT

Payment for all demolition activities shall be covered under the lump sum contract amount.

END OF SECTION 02419

SECTION 02480 - SEEDING

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

DESCRIPTION OF WORK:

Extent of seeding work is shown on drawings and in schedules. All disturbed areas shall be seeded and maintained.

Subgrade Elevations: Excavation, filling and grading required to establish elevations shown on drawings are not specified in this section. Refer to earthwork sections.

QUALITY ASSURANCE:

Source Quality Control:

General: Ship landscape materials with certificates of inspection required by governing authorities. Comply with regulations applicable to landscape materials.

Do not make substitutions. If specified landscape material is not obtainable, submit proof of non-availability to Architect, together with proposal for use of equivalent material.

Analysis and Standards: Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists, wherever applicable.

SUBMITTAL:

Submit seed vendor's certified statement for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed for each grass seed species.

DELIVERY, STORAGE AND HANDLING:

Packaged Materials: Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.

JOB CONDITIONS:

Proceed with and complete seeding work as rapidly as portions of site become available, working within seasonal limitations for each kind of landscape work required.

PART 2 - PRODUCTS

TOPSOIL:

Topsoil may be stockpiled for re-use in landscape work. If quantity of stockpiled topsoil is insufficient, provide additional topsoil as required to complete landscape work.

SOIL AMENDMENTS:

Lime: Natural dolomitic limestone containing not less than 85% of total carbonates with a minimum of 30% magnesium carbonates, ground so that not less than 90% passes a 10-mesh sieve and not less than 50% passes a 100-mesh sieve.

Commercial Fertilizer: Complete fertilizer of neutral character, with some elements derived from organic sources and containing the following percentages of available plant nutrients:

For lawns, provide fertilizer with percentage of nitrogen required to provide not less than 1 lb. of actual nitrogen per 100 sq. ft. of lawn area and not less than 4% phosphoric acid and 2% potassium. Provide nitrogen in a form that will be available to lawn during initial period of growth; at least 50% organic form.

GRASS MATERIALS:

Grass Seed: Provide fresh, clean, new-crop seed complying with tolerance for purity and germination established by Official Seed Analysts of North America. Provide seed mixture composed of grass species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed, as specified.

"SCHEDULE OF GRASS SEED REQUIREMENTS"

		DATES
Tall Fescue	80%	
Kentucky Bluegrass	20%	
@ 200#/Acre		03/01 - 07/01 08/15 - 11/01
Tall Fescue	55%	
Red Clover	25%	
German Millet	20%	

@ 80#/Acre		07/01 - 08/15

In areas where "Crown Vetch" is specified, the following mixture is to be used:

Crown Vetch	25%	
Kentucky 31 Fescue	70%	
English Rye	5%	02/01 - 12/01

PART 3 - EXECUTION

PREPARATION:

Preparation for Planting Lawns:

Loosen subgrade of lawn areas to a minimum depth of 4". Remove stones over 1-1/2" in any dimension and sticks, roots, rubbish and other extraneous matter. Limit preparation to areas which will be planted promptly after preparation.

Spread topsoil to minimum depth required to meet lines, grades and elevations shown, after light rolling and natural settlement. Add specified soil amendments and mix thoroughly into upper 4" of topsoil.

Place approximately 1/2 of total amount to topsoil required. Work into top of loosened subgrade to create a transition layer and then place remainder of planting soil. Add specified soil amendments and mix thoroughly into upper 4" of topsoil.

Apply specified commercial fertilizer at rates specified and thoroughly mix into upper 2" of topsoil. Delay application of fertilizer if lawn planting will not follow within a few days.

Fine grade lawn areas to smooth, even surface with loose, uniformly fine texture. Roll, rake and drag lawn areas, remove ridges and fill depressions, as required to meet finish grades. Limit fine grading to areas which can be planted immediately after grading.

Moisten prepared lawn areas before planting of soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.

Restore lawn areas to smooth, even surface with loose, uniformly fine texture. Roll, rake and drag lawn areas, remove ridges and fill depressions, as required to meet finish grades. Limit fine grading to areas which can be planted immediately after grading.

Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.

Restore lawn areas to specified condition if eroded or otherwise disturbed after fine grading

and prior to planting.

SEEDING NEW LAWNS:

Do not use wet seed or seed which is moldy or otherwise damaged in transit or storage.

Sow seed using a spreader or seeding machine. Do not seed when wind velocity exceeds 5 miles per hour. Distribute seed evenly over entire area by sowing equal quantity in 2 directions at right angles to each other.

Sow not less than the quantity of seed specified or scheduled.

Rake seed lightly into top 1/8" of soil, roll lightly, and water with a fine spray.

SEED PROTECTION:

Cover seeded slopes where grade is 3:1 or greater with jute matting. Roll matting down over slopes without stretching or pulling.

Lay matting smoothly on soil surface, burying top end of each section in narrow 6-inch trench. Leave 12 inches overlap from top roll over bottom roll. Leave 4 inches overlap over adjacent section.

Staple outside edges and overlaps at 36-inch intervals.

Lightly dress slopes with topsoil to ensure close contact between matting and soil. In ditches, unroll matting in the direction of the flow. Overlap ends of strips 6 inches with upstream section on top.

All seeded areas with a slope of less than 3:1 shall be mulched with straw. Spread straw evenly over the seeded areas at an approximate application rate of 75 pounds per 1,000 square feet.

HYDROSEEDING NEW LAWNS:

Mix specified seed, fertilizer and pulverized mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogenous slurry suitable for hydraulic application.

Apply slurry uniformly to all areas to be seeded. Rate of application as required to obtain specified seed sowing rate.

Reconditioning Existing Lawns:

Recondition existing lawn areas damaged by Contractor's operations including storage of materials and equipment and movement of vehicles. Also recondition existing lawn areas

where minor regarding is required.
Provide fertilizer, seed or sod and soil amendments as specified for new lawns and as required to provide a satisfactorily reconditioned lawn. Provide new topsoil as required to fill low spots and meet new finish grades.

Cultivate bare and compacted areas thoroughly to provide a satisfactory, planting bed.

Remove diseased and unsatisfactory lawn areas; do not bury into soil. Remove topsoil containing foreign materials resulting from Contractor's operations including oil drippings, stone, gravel and other loose building materials.

Where substantial lawn remains (but is thin), mow, rake, aerate if compacted, fill low spots, remove humps and cultivate soil, fertilize, and seed. Remove weeds before seeding or if extensive, apply selective chemical weed killers as required. Apply a seedbed mulch, if required, to maintain moist condition.

Water newly planted areas and keep moist until new grass is established.

MAINTENANCE:

Begin maintenance immediately after planting.

Maintain lawns for not less than the period stated below, and longer as required to establish an acceptable lawn.

Seeded lawns, not less than 60 days after substantial completion.

Maintain lawns by watering, fertilizing, weeding, mowing, trimming and other operations such as rolling, regrading and replanting as required to establish a smooth, acceptable lawn, free of eroded or bare areas.

CLEANUP AND PROTECTION:

During landscape work, keep pavements clean and work area in an orderly condition.

PART 4 - MEASUREMENT AND PAYMENT:

No separate measurement and payment will be made for this work. It will be considered a subsidiary obligation of the Contractor under the lump sum price bid for project.

END OF SECTION 02480

SECTION 02667 - WATER MAINS & APPURTENANCES

PART 1 - GENERAL

SCOPE:

The work to be done under this Division shall consist of furnishing all labor, equipment and materials to complete all excavation, embankment and preparation of the sites as shown or noted on the drawings or specified herein or both as follows:

A. Protection against damage to all public and private roads, fences, utilities, etc.
B. Protect all adjoining property from damage that might be done under this contract.
C. Installation of water pipe, valves, and appurtenances.

ELEVATIONS AND GRADES:

Elevations and grade lines shown on the drawings indicate the height in relation to benchmarks noted on the drawings.

The words "finished grades" as used herein refers to the required final grade elevations indicated on the drawings. Should finished grades shown by spot elevations conflict with those shown by contours, such discrepancies shall be referred to the Engineer for adjustment before any work affected thereby is performed.

REFERENCES:

Abbreviations of standards, codes, and publications used within these specifications are as follows:

ANSI	American National Standards Institute
ASTM	American Society of Testing Materials
AWWA	American Water Works Association
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
UL	Underwriter's Laboratory, Inc.

REGULATORY REQUIREMENTS:

Conform to Tennessee, Department of Environment and Conservation and local requirements for materials and installation of the work of this Section.

SUBMITTALS:

Submit shop drawings indicating dimensions, layout of piping, product data, manufacturer's

installation and storage instructions, etc. Refer to Section 01340 and General Conditions.

PROJECT RECORD DOCUMENTS:

Accurately record location of pipe runs, connections, valves, hydrants, etc.

Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 - PRODUCTS

MANUFACTURERS:

Manufacturer's Qualifications: Firms regularly engaged in manufacture of potable water systems, products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

WATER MAINS:

A. Polyvinyl Chloride Pipe:

Class 200 (SDR 21)

PVC pipe shall meet the following ASTM Standards: D-1784 (PVC Compound), D-2241 (PVC Pipe), D-3139 (Joint) and F-477 (Gasket).

Requirements for unplasticized polyvinyl chloride (PVC) pipe with integral thickened wall bell for water supply and distribution systems.

The pipe shall be rated for use in 23°C (73°F) at the maximum internal pressures as follows: SDR 21 (200 PSI). The "extra deep" thickened bell conforms to ASTM D-3139 and is designed to use a dual sealing (hydraulic and compression) rubber ring gasket, seated in a two-step race to prevent push out. The design allows for greater contraction and expansion. The product shall bear the National Sanitation Foundation seal for potable water pipe and be marked in accordance with ASTM D-1784 standard.

The pipe shall be extruded with only Type I, Grade I, 2000 PSI design stress compound meeting ASTM D-1784 standard. The pipe shall be designed to pass, without failure, the burst test for rated class as follows: SDR 21 (630 PSI) when conducted in accordance with ASTM D-1599.

The pipe shall be designed to pass, without failure, the sustained pressure test for 1000 hours for SDR 21 (420 PSI) when conducted in accordance with ASTM D-1598. A two-inch-long sample ring shall not flake or disintegrate when immersed for 20 minutes in a sealed container of acetone when conducted in accordance with ASTM D-2152. (Swelling or softening is not considered a failure).

A two-inch long sample ring shall be compressed between parallel plates to 40% of the outer diameter of the pipe without evidence of splitting, cracking or breaking.

The pipe shall meet the ASTM D-2241 impact resistance when tested in accordance with specification requirements section of method ASTM D-2444.

The pipe shall be white in color.

All pipe shall be furnished in 20' or 40' laying lengths. Forty-foot length will be permitted provided the pipe be transported from the storage area to the laying area on racks specially designed to prevent the ends of the pipe from dragging and that the pipe be handled at all times by a minimum of two workers when being loaded, unloaded, and installed. The contractor shall take all precautions necessary to prevent the pipe from being damaged and shall suspend use of 40-foot sections of pipe should the Engineer so direct.

B. Ductile Iron Pipe: Ductile iron pipe, where used, shall meet the requirements of AWWA C150, latest revision. The pipe shall be Class 350. Pipe and fittings shall have double cement mortar lining and bituminous outside coating in accordance with AWWA C104, AWWA C151 and AWWA C110. The joints for straight runs shall be push-on except for exposed piping, piping in pump stations, and piping in pump valve vaults. Such pipe shall be flanged joints.

Fittings (except as noted above) shall be mechanical joint fittings with body thickness and radius of curvature conforming to AWWA C110-87 rubber gasket joints shall be in accordance with AWWA C111-85. AWWA C-153 compact ductile iron fittings are acceptable. The primer for the ductile iron pipe shall be TNEMEC Series 66, Hi-Build Expoxoline, or equal.

Ductile fittings shall be used with all types of pipe 3" and larger unless otherwise shown on the drawings. Other fittings for pipes 2" and smaller shall be of the same material as the pipe.

Gasket material shall be rubber, either ring or full face, 1/8 inch thick. Bolting for “buried” piping and fittings shall be ASTM A307, Grade B with ASTM A, A563A nuts and F844 washers. Bolting for exposed (concrete valve boxes, dry wells, buildings, etc.) piping and fittings shall be Grade B8, Class 2 (Stainless Steel 304) with A194, Grade 8 nuts and Stainless Steel 304 washers.

VALVES:

Unless otherwise specified, valves shall be designed to operate continuously under a working pressure of not less than 200 pounds per square inch. Valves suitable for other working pressures shall be furnished as indicated on the drawings. A steel valve marker post and sign shall be erected at the location of each valve. All valves shall be mechanically jointed unless otherwise specified.

All gate valves 2" and larger shall conform to AWWA C500-86. All valves of the above sizes, unless otherwise stipulated, shall be iron body, bronze mounted, resilient, non-rising stem type.

Valve boxes shall be installed with the opening centered over the valve-operating nut. The bottom of the section of the valve box shall be at or below the bottom of the operating nut on the valve. Do not allow the valve box to rest directly on the pipe or valve. Use blocks or brick to support the valve box base. Valve box and lids shall be manufactured by Capitol Foundry of Virginia, Inc., Opelika Foundry, Sigma Corporation, or approved equal.

All butterfly valves 10" and larger shall conform to AWWA C504-80. Valve body shall be cast iron with stainless steel body seat. Vane shall be cast iron with a mechanically secured rubber seat. Valve operator shall be traveling-nut type for underground service.

The air relief valves shall be the same or equal to the Crispin pressure relief valve as manufactured by the Multiplex Manufacturing Company with 3/4" inlet connection and a working pressure range of 0-200 psi. A 3/5" bronze double gate valve brass pipe and fittings shall be used on the installation. The installation be consistent with manufacturer recommendations with approval from the Engineer.

At the end of each dead-end line or at other locations as directed by the Engineer, shall be installed a blow-off valve. The gate valve shall be the same as specified above. Installation shall be as shown in the Standard Details.

All valves shall be tested in the shop at no cost to the owner under a test pressure equal to twice the working pressure and upon request by the owner, and valves shall be furnished with a certificate stating that all valves have successfully passed such a test.

Where specified on the drawings, flexible elastomeric thermal insulation shall be used. The pipe insulation shall be 1" AP Armaflex pipe insulation with an outdoor, weather-resistant protective finish (Armstrong Armaflex Finish) or other approved equal.

PART 3 - EXECUTION

GENERAL:

Under this section is included the inspection, laying, jointing, and testing of all water pipe, including water appurtenances, both in open cut and in tunnels, as shown on the drawings or as directed by the Engineer.

PIPE INSPECTION PRIOR TO LAYING:

All pipe shall be inspected just prior to laying. If any portion of a shipment is found to be defective in diameter or thickness, the entire shipment shall be removed from the project at the Contractor's expense. Ductile iron pipe shall, while suspended, be visually inspected for

defects and rung with a light hammer to detect cracks.

Any defective pipe will be rejected. All such rejected pipe shall be removed from the project immediately and replaced at the expense of the Contractor. Usable portions of the rejected pipe may be salvaged upon approval of the Engineer. Minimum manufacturer's standard shall be met on all salvaged pipe.

HANDLING OF MATERIALS:

Care shall be exercised in loading and unloading pipe to prevent damage to the pipe. The degree of care in handling the pipe and accessories shall meet the recommendations of the pipe manufacturer.

Proper implements, tools, and facilities shall be provided to allow safe and convenient execution of the work. Under no circumstances shall pipe or accessories be dropped into the trench.

Care shall be exercised to keep pipe clear of mud, dirt, and debris before and during laying.

No pipe shall be laid in water, and precautions shall be taken to prevent trench water from entering the pipe.

PROTECTION:

The Contractor shall assume responsibility for protection of benchmarks, monuments, and other reference points. The Contractor shall replace, as directed, any reference points removed or destroyed during construction.

The Contractor shall assume responsibility for protection of public streets, curbs, and utilities from damage from the Contractor's operations. Plan work to avoid ponding, flooding, and washing on site and upon adjacent property. Care shall be taken to avoid obstruction of flow of natural runoff.

Meet the requirements of all rules and regulations governing the respective utilities. Protect active utilities from damage during construction.

Provide, set and remove all bracing, shoring and sheet piling required to prevent cave-ins.

Provide and maintain all pumping facilities required to keep excavations free of water. Water should not be conducted onto adjacent property.

Required blasting shall be performed using the minimum practical charges and in strict accordance with all regulations governing this work. All required precautions shall be taken to prevent damage to persons and property.

SILTATION AND SOIL EROSION:

Siltation and soil erosion must be minimized during construction. Refer to Section 02260 of these specifications.

WATER TRENCH EXCAVATION:

General: Under this section is included the removal and disposal of all materials, in both open cut and tunnel excavations, necessary for performing the work as shown on the drawings or called for in the bid or addenda, including sheeting and bracing, drainage and other work incidental to the preparation of the site for water pipe installation.

Drainage: The Contractor shall make provisions for handling all flows in existing creeks, ditches, and trenches by pipes, flumes or other approved methods always when his operations would, in any way, interfere with the natural functioning of said creeks, ditches, and drains. the Contractor shall at all times during construction provide and maintain sufficient equipment for the disposal of all water which enters the excavation, both in open cut trenches and in tunnels, to render such excavation firm and dry, until the structures to be built thereon are completed, at no additional cost to the Owner.

Excavated Materials: Materials of excavation shall include whatever materials are encountered to the depth shown on the drawings, or as directed by the Engineer.

Disposal of Unsuitable Materials: Excavated materials which are either surplus and not required or are unsuitable for back filling shall be removed from the site of operations as soon as excavated. All excavated materials so removed shall be disposed of at locations obtained by the Contractor. The Contractor shall secure written permission from the property owner(s) and furnish the Engineer with a copy of the agreement(s).

Storage of Suitable Materials: Excavated materials suitable and required for backfill shall be stored in neat piles adjacent to the excavation in a manner so as to interfere as little as possible with traffic, but shall not be placed at such heights above or closeness to the sidewalls of the excavation to endanger such operations due to slides or cave-ins.

Open-Cut Excavation: Open-cut excavation, either in earth or rock, shall be safely supported and of enough width and depth to provide adequate room for the construction or installation of the work to the lines, grades and dimensions called for by the drawings. Trenches shall not remain open overnight or any time the Contractor is not on the job site.

Trench Dimensions: Excavations for water pipe in both earth and rock shall have a minimum and maximum allowable trench width below the outside top of the water pipe as shown on the drawings.

1. Allowable Width: The required width of the trench will vary according to the size of the water pipe to be installed, as shown on the drawings. If the maximum allowable trench width 12" above the top of the water pipe is exceeded, a higher strength classification of water pipe of enough strength for that trench width will be required, at no additional cost to the Owner.

2. Sub-Grade: The required depth of sub-grade below the outside diameter of the water pipe will be as shown on the drawings.

3. Unsuitable Foundation: When the bottom of the excavation is unsuitable as a foundation, it shall be excavated below sub-grade and then refilled with concrete or compacted crushed stone to the sub-grade as the Engineer may direct. Such authorized work shall be paid for as set forth under the appropriate item of the Bid.
4. Unauthorized Excavation: Unauthorized excavation below sub-grade shall be filled with crushed stone or concrete as ordered and directed by the Engineer at no additional cost to the Owner.

Rock Excavation:

1. When rock is encountered in open cut excavation, it shall be removed by drilling, blasting, digging or other approved methods so that the open cut trenches conform with the lines, grades and dimensions shown on the drawings. The Contractor shall notify the Engineer prior to removal of any rock.

2. Blasting:

When blasting is required for the removal of rock, every precaution shall be used for the protection of persons and private and public property. Each blast shall be well covered with mats or other suitable means to confine the rock fragments within the excavation. Only the minimum amounts of explosives shall be used; no excessive charges will be permitted. Blasting shall be performed at a safe distance ahead of the installation of the water pipe and structures to prevent damage to them as the work progresses. Blasting of rock for property service connections, T-branches, Y-branches, and studs shall be performed at the same time as the water pipe trench blasting. The rock shall be shattered by continuing the drilling and blasting operations 6 feet beyond the end of the water pipe, branch, stub or property service connection. Except with written permission and approval of the Engineer, no blasting of rock will be permitted at nights or on Sundays.

3. Unauthorized Excavation:

If, for any reason, rock is excavated beyond the necessary limits as shown on the drawings, such unauthorized excavation, or over breakage, shall be refilled with crushed stone or concrete as directed by the Engineer, at no additional cost to the Owner.

4. Rock and Backfill:

All excavated rock permitted to be used for backfilling purposes shall be used in accordance with these Specifications. All rock specified as unsuitable for backfill shall be removed from the site of the work at no additional cost the Owner.

SHEETING & BRACING:

General: The Contractor shall furnish, place and maintain adequate sheeting and bracing as may be required to support the sides of the excavation and prevent any movement of earth which could, in any way, diminish the width of the excavation to less than that necessary for proper construction, cause damage to the water pipe or structure being constructed or to adjacent structures, utilities, pavements or walks, or cause injury to workmen or others through movement of the adjacent earth banks, or to otherwise damage or delay the works.

Supports: Sheeting may be of wood or steel and shall be of adequate strength for the excavation.

Methods: Wherever possible, the sheeting and bracing shall be driven ahead of the excavation to avoid loss of material from behind the sheeting. If it is necessary to excavate below the sheeting, care shall be taken to avoid trimming behind the face along where the sheeting will be driven. Care shall be taken to prevent voids outside the sheeting; but, if voids develop, they shall be immediately filled with selected sandy materials and compacted as directed by the Engineer.

Left-in Place: The Engineer may order sheeting and bracing to be left in place at locations other than shown on the drawings. Sheeting left in place may be ordered to be cut off at any specified elevation, but in no case shall it be left in the ground above an elevation 18 inches below the existing or proposed surface of the ground. All voids created by the cutting of the sheeting to be left in place shall be immediately filled with selected sandy materials and compacted as directed by the Engineer.

Sheeting and bracing left in place in open cut trenches as shown on the drawings or as ordered by the Engineer shall be paid for under the appropriate items of the Bid. If the Contractor elects not to remove certain sheeting and bracing, he will not be paid additionally for such sheeting and bracing left in place. Any sheeting left in place at the Contractor's option must be approved by the Engineer.

Not Left-in Place: All sheeting and bracing not to be left in place shall be carefully removed (after the backfill is complete) to not endanger the water pipe and other structures. All voids created by withdrawal of the sheeting shall be immediately filled with selected sandy materials and compacted as directed by the Engineer.

OPEN-CUT PIPE LAYING:

Water Pipe: All pipe shall be laid to the required grade and alignment. Any deviations from the alignment and grade shown on the drawings shall be as directed by the Engineer. Minimum cover over mains shall be 30 inches. Holes shall be excavated at the bell and/or coupling locations to prevent load concentration on the bell and/or couplings.

Fittings and valves shall be located at the plan location with all joints centered, spigots home, and valve stems plumb.

Jointing: All joints shall be water-tight, and any leaks or defects discovered shall be immediately repaired to the satisfaction of the Engineer. Any pipe which has been disturbed after being laid shall be taken up, the joints cleaned, and the pipe properly re-laid. Damaged or unsound pipe or fittings will be rejected. Before jointing the pipe, all lumps, blisters, excess coating material, and any dirt or sand shall be removed from the ends of pipes. Any superfluous material inside the pipe shall be removed by means of an approved follower or scraper after joints are made.

Factory-made joint materials shall be utilized. Installation shall be accomplished in strict accordance with the manufacturer's recommendations and with approval from the Engineer.

When lowered into the trench, the spigot, bell and gasket shall be cleaned in accordance with the manufacturer's recommendations. The pipe shall be pushed home and the gasket pressed firmly and evenly around the entire socket. The gland then pushed up to the bell and centered on the spigot of the pipe. Glands for large diameter pipe may require a wedge under the top side to assist in centering the gland lip against the gasket. The bolts are then inserted and tightened with the fingers until all are even. The bolts shall then be tightened as recommended by the manufacturer.

In no case shall water be allowed to rise in or above the pipe before the joint has become thoroughly set. No walking on or working over the pipe after they have been laid, except as may be necessary in placing and compacting the backfill, will permitted until they are covered with backfill to a depth of 24 inches.

CUTTING PIPE:

Cutting of pipe for the insertion of valve fittings shall be done in a manner recommended by the manufacturer to avoid damage to the pipe or coating.

PERMISSIBLE DEFLECTION AT JOINTS:

The degree of deflection of a pipe in either the horizontal or vertical planes shall be as directed by the Engineer but shall in no case exceed the recommendations of the manufacturer.

DITCH, STREAM, HIGHWAY & RAILROAD CROSSINGS:

Pipes crossing under ditches and streams shall be as shown on the drawings with bends not exceeding the angles shown. Joints at angles shall be securely fastened with bolted legs or clamps to prevent the pipe from pulling apart.

Pipes crossing under highways shall be as indicated on the detailed construction drawings.

CRADLE AND ENCASEMENT:

General: The cradle or encasement, as required to support and protect the water pipe, shall be installed as specified herein, as directed, or as necessitated by the Contractor's

operations.

Crushed Stone or Sand Cradle: Where the water pipe is to be laid in a crushed stone cradle, the crushed stone shall meet requirements for Class "B" aggregate, Grading "D" as defined by current Tennessee Department of Transportation Standard Specifications For Road and Bridge Construction. The crushed stone shall be deposited in the excavated trench to grade, allowing for the water pipe wall thickness and joints.

Concrete Encasement: If the water pipe to be laid will have less than 2 feet of clearance between it and an existing or proposed storm drain or utility conduit, or if it is to be located within a street right-of-way and will have less than 30 inches of cover, concrete encasement shall be required to protect the water pipe. The length of water pipe to be encased shall be at least 2 feet beyond the outside diameter of the storm drain or utility conduit, as directed. Concrete shall be of composition specified within Division 3. The water pipe shall be laid and supported in accordance with the specifications for water pipe on a concrete cradle, as heretofore specified, and the concrete deposited around the pipe at the required width and depth to a plane at least 6 inches over the top of the pipe, as indicated on the drawings. Proper bracing of the pipe shall be provided to prevent its being floated by the concrete encasement.

SEPARATION OF WATER MAINS AND SEWERS:

General: The following factors should be considered in providing adequate separation:

(1) Materials and type of joints for water and sewer pipes;
(2) Soil conditions;
(3) Service and branch connections into water main and sewer line;
(4) Compensating variations in the horizontal and vertical separations;
(5) Space for repair and alterations of water and sewer pipes;
(6) Off-setting of pipes around manholes.

Horizontal Separation: Whenever possible, water mains should be laid at least 10 feet horizontally from any existing or proposed sewer lines. Should local conditions prevent a lateral separation of 10 feet, they may be laid closer than 10 feet if:

(1) The water line is laid in a separate trench, and if
(2) The elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.

Vertical Separation: Whenever water mains must cross over sewer lines, the water lines shall be laid at such elevation that the top of the sewer is at least 18 inches below the bottom of the water main. If this requirement cannot be met, the sewer main shall be relocated to provide this separation.

Other Protection: When it is impossible to obtain proper horizontal and vertical separation as stipulated above, both the water main and sewer shall be constructed of mechanical-joint cast-iron pipe and shall be pressure-tested to assure water tightness. One full length of

water main should be centered over the sewer so that both joints will be as far from the sewer as possible.

Sewer Manholes: No water pipe shall pass through or encounter any part of a sewer or sewer manhole.

ANCHORAGE OF BENDS, TEES AND PLUGS:

All pipelines, all plugs capped and bends equal to or exceeding 22½ degrees shall be securely anchored by thrust blocking as indicated in the standard drawings. In addition, on a 4" or larger pipeline, all tees shall be similarly anchored. Thrust blocking shall be concrete of a mix not leaner than 1-part cement, 2 ½ parts sand, 5 parts stone and a compressive strength not less than 2,000 pounds per square inch. Quantities of concrete required for different bends, tees, and valves shall be as indicated on the standard drawings. If permitted by the Engineer, metal harness rods and pipe clamps of adequate strength to prevent movement may be used in lieu of concrete blocking.

WATER PIPE BACKFILL:

General: Under this section is included the filling of the excavation trenches and spaces around the completed structures, in both open cut and tunnel excavation, to the original grades, unless otherwise shown on the drawings.

Open Cut Backfills: Backfilling of excavated trenches in open cut shall commence as soon as possible after the water line is laid and the jointing and alignment are approved, but not until authorized by the Engineer.

Materials: The following materials shall be used to backfill the trenches in accordance with and in the manner indicated by the requirements specified herein:

1. Stone: Backfill in trenches within the limits of existing or proposed paved surfaces or shoulders, where defined in the drawings or authorized by the Engineer, shall be made with crushed stone, crushed slag or washed gravel meeting the requirements of the Tennessee Department of Transportation Standard Specifications. The backfill shall extend from the top of the bedding to the bottom of the existing or proposed paving base.

2. Selected Excavated Materials: Backfill in trenches for water lines shall be made with selected excavated materials taken from the trench excavation except where stone backfill is required or the excavated materials are not suitable. The selected excavated materials used from the top of the pipe to 2 feet above the top of the pipe shall contain no rocks. The selected excavated backfill materials used between the plane 2 feet above the top of the pipe or structure and one foot below the ground surface may include rock fragments taken from the excavation. In backfill containing rock, the maximum dimension along any axis of rock shall not exceed six inches, and all rock fragments shall be mixed with enough earth materials to eliminate all voids, subject to the approval of the Engineer. The amount of rock in the backfill shall not

exceed 33% of the total backfill. Rock fragments and surplus earth materials not used in the backfill shall be removed from the site of the work at no expense to the Owner.

Compaction of Backfill: Backfill material shall be compacted as indicated on the drawings or allowed by the Engineer.

Depositing Backfill: If materials for any method of backfilling is dumped, bulldozed, or dropped from a height exceeding 5 feet above the previously placed backfill, its fall shall be broken by timber grillage or other means acceptable to the Engineer to prevent possible damage to the water lines.

Backfill Around Iron Pipes: Selected excavated materials composed of clay, sand, gravel or other materials non-injurious to iron pipe shall be used for backfilling within 24 inches of iron pipe. Cinders, rubbish and other materials which would be injurious to iron pipe shall not be used in such backfilling.

Additional Backfill Materials: Backfill materials required in addition to that which are available shall be purchased by the Contractor, subject to the approval of the Engineer, at no additional cost to the Owner.

LEAKAGE TESTS:

General:

The Contractor shall fully test all sections of water lines in accordance with the procedures to follow. All labor, materials and equipment used in testing procedures (including water) shall be furnished by the Contractor.

Hydrostatic Tests: After water pipe has been laid and backfilled, all newly laid pipe or any valve section thereof shall be subject to a hydrostatic pressure of not less than 200 psi or 1 1/2 times anticipated line pressure, whichever is greater. The duration of the pressure tests shall be two hours. Each valve section of pipe shall be slowly filled with water. While the pipe is being filled and before the application of the specified test pressure, all air shall be expelled from the pipe. Taps may be required at points of highest elevation. These taps are to be tightly plugged after completion of the test.

The test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. The pump, pump connections, gauges, and all necessary apparatus and labor shall be furnished by the Contractor. The Contractor shall calibrate the gauges in the presence of the Engineer.

A test shall be made only after a part or all of the backfilling has been completed and at least 36 hours after the last concrete thrust block has been cast with high-early-strength cement or at least seven (7) days after the last thrust block has been cast using standard cement.

Any cracked or defective pipes, fittings, or valves discovered during hydrostatic pressure tests shall be removed and replaced with sound material and the test repeated until satisfactory to the Engineer. No payment shall be made for the removal and replacement of defective pipes and appurtenances.

Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain pressure within 5 psi of the specified test pressure. Leakage shall not be measured by a drop-in pressure in a test section over a period. See Table 1 below:

Table 1. Allowable leakage per 1000 ft of pipeline* - gph†

Avg. Test Pressure psi	NOMINAL PIPE DIAMETER-in.																	
	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54	60	64
450	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60	9.56	10.19
400	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11	9.01	9.61
350	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58	8.43	8.99
300	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02	7.80	8.32
275	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72	7.47	7.97
250	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41	7.12	7.60
225	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03	6.76	7.21
200	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73	6.37	6.80
175	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36	5.96	6.36
150	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97	5.52	5.88
125	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53	5.04	5.37

	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54	60	64
100	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05	4.50	4.80

*If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.
†Calculated on the basis of Eq.1.

Allowable leakage. No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

In inch-pound units,

$$L = \frac{SD\sqrt{P}}{133{,}200}$$

Where:

L = allowable leakage, in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of the pipe, in inches
P = average test pressure during the leakage test, in pounds per square inch (gauge)

DISINFECTION OF PRESSURE WATER PIPELINES:

Before being placed into general use all pressure water piping and pipelines shall be flushed thoroughly, disinfected with chlorine and flushed again, in accordance with sound engineering practice. The method of disinfection shall consist of introducing a solution of hypochlorite or chlorine and water in controlled quantities into the piping system in such proportion that the chlorine water mixture entering the pipes shall contain at least 50 ppm of chlorine. Outlets in the piping shall be opened to ensure complete distribution of the chlorine water mixture throughout the system to be disinfected. the mixture shall remain in the system long enough to destroy all non-spore forming bacteria. The period shall be at least 24 hours and shall be for a longer length of time should the Engineer so direct. The chlorine residual at the end of the required retention time shall be at least 25 ppm at pipe extremities. If the residual is less than 25 ppm, the disinfection procedures shall be repeated until a 25-ppm residual after retention is obtained at the pipe extremities.

Upon completion of the distribution process, the chlorine water mixture shall be flushed thoroughly from the system and samples for bacteriological examination shall be taken from the system to assure that complete disinfection has been accomplished. Arrangements for bacteriological sampling and examination shall be made by the Contractor with the local county health department or the Tennessee Department of Public Health. Water samples may be taken at such locations as representatives of the Health Department shall select, and no mains shall be placed into service until the bacteriological quality of the water is satisfactory for drinking purposes and the approval of the Department of Health is obtained.

The Contractor shall repeat the disinfection procedure until samples indicate proper

bacteriological quality and the approval of the Health Department is given.

All expenses for testing, disinfecting and flushing prior to approval and acceptance of the work shall be borne by the Contractor. Water for testing, disinfecting and flushing will be furnished by the Owner.

SETTING VALVES, VALVE BOXES & FITTINGS:

All gate valves and any other valves designated shall be set-in cast-iron Buffalo type, two-piece screw type valve boxes unless otherwise indicated on the plans. Wrench nuts shall be readily accessible through the opening. Valve boxes shall be firmly supported and shall be kept centered and plumb over the wrench nut of the gate valve. The box cover shall be flush with the surface of the finished pavement or any other level designated by the Engineer. Extended stems (from valve to surface) with centering inserts shall be provided for all buried valves.

Drainage branches or blow-offs shall not be connected with any sewer or submerged in any stream or be installed in any other manner which will permit back siphonage into the distribution system.

SETTING OTHER DEVICES:

Check, relief valves, backflow preventors, or any other appurtenances required in connection with the mains or their appurtenances shall be installed in accordance with applicable specifications applying to other valve fittings, and subject to any further detailed requirements included in the plans.

PLUGGING DEAD ENDS:

Standard plugs shall be inserted into the bells of all dead-end fittings. Spigot ends shall be capped. Thrust blocking shall be provided at all dead ends of pipe that are capped or plugged.

UTILITIES RELOCATION AND REPAIR:

Contractor shall relocate or repair any utility lines damaged during construction. No separate payment will be made for repair or replacement.

All repair materials shall be equal to type of pipeline damaged and repaired to the satisfaction of the utility owner.

Contractor shall notify the local utility offices prior to construction and locate where possible all existing service lines, valves, etc. All other utilities shall be maintained during construction.

All repair materials shall be approved by Tennessee Department for Environment and Conservation or other regulatory agency. Contractor shall submit shop drawings on

anticipated repair materials unless the materials are provided by the utility owner.

PART 4 - PAYMENT

All pipes, valves, fittings, installation, testing, etc. shall be included in lump sum bid for project and will not be considered for direct payment.

END OF SECTION 02667

SECTION 02730 - SANITARY SEWAGE SYSTEMS

PART 1 - GENERAL

SCOPE:

The work to be done under this Division shall consist of furnishing all labor, equipment and materials to complete all excavation, backfill, and installation of the plant sewer piping as shown or noted on the Drawings or specified herein or both as follows:

A. Protection against damage to all public and private roads, fences, utilities, etc.
B. Protect all adjoining property from damage that might be done under this contract.
C. Installation of gravity sewer pipe, manholes and appurtenances.
D. Installation of force main sewer pipe and appurtenances.
E. Installation of plant process piping and appurtenances.
F. Installation of plant air piping.

ELEVATIONS AND GRADES:

Elevations and grade lines shown on the Drawings indicate the height in relation to benchmarks noted on the Drawings.

The words "finished grades" as used herein refers to the required final grade elevations indicated on the Drawings. Should finished grades shown by spot elevations conflict with those shown by contours, such discrepancies shall be referred to the Engineer for adjustment before any work affected thereby is performed.

REFERENCES:

Abbreviations of standards, codes, and publications used within these Specifications are as follows:

AWWA	American Water Works Association
ASTM	American Society of Testing Materials
ANSI	American National Standard Institute
NEMA	National Electrical Manufacturers Association

REGULATORY REQUIREMENTS:

Conform to Tennessee Department of Environment and Conservation and local requirements for materials and installation of the work of this Section.

SUBMITTALS:

Submit Shop Drawings indicating dimensions, layout of piping, line profiles/grades for all gravity lines, manhole and other product data, manufacturer's installation and storage instructions, etc.

PROJECT RECORD DOCUMENTS:

Accurately record location of pipe runs, connections, manholes, cleanouts, valves, and invert elevations.

Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 - PRODUCTS

MANUFACTURERS:

Manufacturer's Qualifications: Firms regularly engaged in manufacture of sanitary sewage systems products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

MATERIALS:

Unless otherwise specified all wastewater piping exposed, inside basins, in pump station wet wells, and in the pump station valve pits shall be flanged ductile iron.

In areas where exposed piping is noted to be PVC it shall be schedule 80.

All wastewater piping having less than three foot of cover shall be ductile iron with restrained type joints.

All wastewater piping having more than three feet of cover shall be ductile iron unless otherwise noted. The pressure pipe (force mains) shall be either PVC SDR 21 (if cover is more than 3’ deep), or ductile iron with push-on joints unless otherwise noted.

The PVC (gravity) can be either SDR 35, SDR 21, or C900. The ductile iron used for gravity lines shall be push-on joints and be Class 350.

Where specified on the drawings, flexible elastomeric thermal insulation shall be used. The pipe insulation shall be 2" AP Armaflex pipe insulation with an outdoor, weather-resistant, protective finish (Armstrong Armaflex Finish) or other approved equal.

The pipe materials shall be as specified below:

A. Polyvinyl Chloride Pipe (Force Main):

Class 200 (SDR 21)

PVC pipe shall meet the following ASTM Standards: D-1784 (PVC Compound), D-2241 (PVC Pipe), D-3139 (Joint) and F-477 (Gasket).

Requirements for unplasticized polyvinyl chloride (PVC) pipe with integral thickened wall bell for water supply and distribution systems.

The pipe shall be rated for use in 23°C (73°F) at the maximum internal pressures as follows: SDR 21 (200 PSI). The "extra deep" thickened bell conforms to ASTM D-3139 and is designed to use a dual sealing (hydraulic and compression) rubber ring gasket, seated in a two-step race to prevent push out. The design allows for greater contraction and expansion. The product shall bear the National Sanitation Foundation seal for potable water pipe and be marked in accordance with ASTM D-1784 standard.

The pipe shall be extruded with only Type I, Grade I, 2000 PSI design stress compound meeting ASTM D-1784 standard. The pipe shall be designed to pass, without failure, the burst test for each rated class as follows: SDR 32.5 (400 PSI), SDR 26 (500 PSI) and SDR 21 (630 PSI) when conducted in accordance with ASTM D-1599.

The pipe shall be designed to pass, without failure, the sustained pressure test for 1000 hours for SDR 21 (420 PSI) when conducted in accordance with ASTM D-1598. A two-inch long sample ring shall not flake or disintegrate when immersed for 20 minutes in a sealed container of acetone when conducted in accordance with ASTM D-2152. (Swelling or softening is not considered a failure).

A two-inch long sample ring shall be compressed between parallel plates to 40% of the outer diameter of the pipe without evidence of splitting, cracking or breaking.

The pipe shall meet the ASTM D-2241 impact resistance when tested in accordance with specification requirements section of method ASTM D-2444.

All pipe shall be furnished in 20' or 40' laying lengths.

B. PVC (GRAVITY SEWER PIPE):

(SDR 35).

PVC Gravity Sewer Pipe shall meet the following ASTM Standards D-3034 and D-1749 (PVC Compound):

Requirements for unplasticized polyvinyl chloride (PVC) integral bell rubber ring gasket joint gravity sewer pipe for conveyance of domestic sewage.

The pipe shall be joined with an integral bell rubber ring gasket allowing for contracting and expansion at each joint. Joint tightness shall be tested in accordance with ASTM D-3212.

The pipe shall meet ASTM D-1784 standards which require the PVC plastic to have a cell classification of 12454-B, 12454-C or 13364-B, with a minimum tensile modules of 500,000 PSI.

A sample ring, six inches long, shall be subjected to ASTM D-2412 test for minimum pipe stiffness (F/Ay) at 5% deflection and shall be 46 PSI for all sizes.

The gasket shall be secured in the race by means of a non-metallic polypropylene retainer ring or other method approved by the Engineer.

All pipe shall be furnished in 12.5' or 20' laying lengths.

Foundation drainage pipe away from proposed structures shall be SDR35 also.

Fittings: Ductile iron fittings shall be used with all types of pipe 3" and larger unless otherwise shown on the drawings. Fittings shall be mechanical joint fittings with body thickness and radius of curvature conforming to AIWA C110-87 rubber gasket joints and shall be in accordance with AIWA C111-85. Other fittings for pipes 2" and smaller shall be of the same material as the pipe.

C. Ductile Iron Pipe (Gravity or Force Main):

Ductile iron pipe, where used, shall meet the requirements of AWWA C150, latest revision. The pipe shall be Class 350. Pipe and fittings shall have double cement mortar lining and bituminous outside coating in accordance with AWWA C104, AWWA C151 and AWWA C110. The joints for straight runs shall be push-on except for exposed piping, piping in pump stations, and piping in pump valve vaults. This pipe shall be flanged joints.

Fittings (except as noted above) shall be restrained type joint fittings with body thickness and radius of curvature conforming to AWWA C110-87 rubber gasket joints shall be in accordance with AWWA C111-85. AWWA C-153 compact ductile iron fittings are acceptable. The primer for the ductile iron pipe shall be TNEMEC Series 66, Hi-Build Epoxoline, or equal.

Gasket material shall be rubber, either ring or full face, 1/8 inch thick. Bolting for “buried” piping and fittings shall be ASTM A307, Grade B with ASTM A, A563A nuts and F844 washers. Bolting for exposed (concrete valve boxes, dry wells, buildings, etc.) piping and fittings shall be Grade B8, Class 2 (Stainless Steel 304) with A194, Grade 8 nuts and Stainless Steel 304 washers.

Acceptable restrained pipe fittings include Field-Lock Gaskets, TR-Flex, Mega lug, or other equal.

D. Piping for Compressed Air:

Air piping where noted on the plans shall be flanged or welded 304 (Type L) Stainless steel, Schedule 10, or ductile iron pipe unlined, Class 200, for exposed pipe areas/applications. Metal air piping shall be painted/coated whether exposed, buried, or submerged per section 09900.
Air piping that is submerged below water level can be PVC schedule 80 provided the compressed air temperature does not exceed the pipe’s temperature rating. Gasket material for air piping shall be rated for the discharge temperature at the blower. For all other applications where temperature cannot be verified, provide VITON rated for 300 degrees F. Gaskets shall be 1/8” thick. Air piping drilling shall be 150lb drilling pattern.

PRE-CAST MANHOLES:

Pre-cast manholes shall be constructed of 4,000 psi reinforced concrete. Materials, reinforcement and mix for the Concrete shall be as specified in Section 3, Concrete. Reinforcing shall be as specified in ASTM C478.

Components of the manhole shall be free of fractures, cracks, and undue roughness. Concrete shall be free of defects which indicate improper mixing or placing, and surface defects such as honeycomb or spalling. Cracks or broken ends due to improper handling will not be acceptable. No lift holes will be allowed, except in riser and corbel sections. These holes shall not penetrate the wall. All manhole joints shall be by means of confined O-ring rubber gasket joints conforming to the applicable provisions of ASTM C361 and ASTM C443 or Butyl Resin Conseal.

Depth of manhole shall be measured from invert elevations to top of lid.

After manholes have been installed, lift holes and all joints shall be mortared over.

Drop Inlets: Drop inlets shall be constructed of materials indicated on the Drawings.

Manhole Steps: Manhole steps shall be ductile iron type as manufactured by Neenah (or equal) as detailed on the Drawings. The steps shall be built into the walls to form a continuous vertical ladder with a maximum distance of 16 inches between steps when the manhole is constructed. The steps shall be coated with asphalt paint. Polymer coated cast iron or steel steps will also be acceptable materials.

Manhole Frames and Lids: Where noted on Drawings, waterproof manhole frames with bolted lids, similar to Neenah Catalog No. R-1915-J, shall be furnished. All other frames and lids shall be similar or equal to Neenah No. R-1733-1. Lids are to be solid and lettered "Sewer". All manhole frames shall be furnished with anchor lugs similar or equal to Neenah Catalog No. R-1768 or shall be anchored to manhole as detailed on the Drawings.

VALVES:
Valves shall be furnished and installed as indicated on the Drawings.

The air release valves shall be the same or equal to the Apco Model 400 (short height). The valve inlet must be 2". The valve shall be fitted with blow-off valves and quick-disconnect couplings to permit back flushing after installation without dismantling the valve. Two hoses with quick disconnect couplings are to be furnished to Owner to use for back flushing these valves.

The Contractor shall furnish a minimum of three keys for each size of operating nuts utilized on the project.

All butterfly valves shall be M&H Model 4500 resilient seated, or Pratt, rated at 200 psi, or equal.

Mud valves shall be M&H bronze resilient seated, provided with extension stems as needed and handwheels, or equal.

Check valves shall be M&H Model 159 swing type, or equal. Where cushioning type is noted

the check valves shall be APCO 6000 or Milliken Model 9001 or equal.

Plug valves shall be Golden Andersen with full round port, 200 psi rating, or equal.

Knife gate valves shall be resilient ring seal seated type by DeZurik or equal.

Sluice gate valves shall be Troy Model A3500 resilient seated, with extension stem or equal.

Ball valves shall be Velan, SB 150 split body, cast carbon, or equal with manual gear actuators.

Valves for compressed air shall be rated for 300 degrees F.

SUPPORTS:

Supports for all stems, piping, etc., needing supports and straps (as shown on the Drawings or where needed) shall be furnished and shall be aluminum unless otherwise permitted by the Engineer. Stem guide/wall bracket assemblies shall be Troy Model A25670 or A25670B, or equal. Floor stands shall be Troy A25650 or A25655, or equal. Floor boxes shall be Troy Model A25700 or A25700B, or equal.

PIPE COUPLINGS:

Where noted on the drawings, pipe couplings for plain end (PE) to PE pipe connections shall be restrained type, Model 400 RG by Romac Industries Inc, for sizes 14” and up. Use Mega Coupling Series 3800 from EBAA Iron Inc., for PE to PE pipe connections from 4” to 12” sizes. For pipes smaller than 4” size, use Dresser Coupling Style 38.

PART 3 - EXECUTION

GENERAL:

Under this section is included the inspection, laying, jointing, and testing of all sewer pipe, including sewer appurtenances, as shown on the Drawings or as directed by the Engineer.

PIPE INSPECTION PRIOR TO LAYING:

All pipe shall be inspected just prior to laying. If any portion of a shipment is found to be defective in diameter or thickness, the entire shipment shall be removed from the project at the Contractor's expense. Ductile iron pipe shall, while suspended, be visually inspected for defects and rung with a light hammer to detect cracks. Any defective pipe will be rejected.

All such rejected pipe shall be removed from the project immediately and replaced at the expense of the Contractor. Usable portions of the rejected pipe may be salvaged upon approval of the Engineer. Minimum manufacturer's standard shall be met on all salvaged pipe.

PROTECTION:

The Contractor shall assume responsibility for protection of benchmarks, monuments, and

other reference points. The Contractor shall replace, as directed, any reference points removed or destroyed during construction.

The Contractor shall assume responsibility for protection of public streets, curbs, and utilities from damage from the Contractor's operations. Plan work to avoid ponding, flooding, and washing on site and upon adjacent property. Care shall be taken to avoid obstruction of flow of natural runoff.

Meet the requirements of all rules and regulations governing the respective utilities. Protect active utilities from damage during construction.

Provide, set and remove all bracing, shoring and sheet piling required to prevent cave-ins.

Provide and maintain all pumping facilities required to keep excavations free of water. Water should not be conducted onto adjacent property.

Required blasting shall be performed using the minimum practical charges and in strict accordance with all regulations governing this work. All required precautions shall be taken to prevent damage to persons and property.

SILTATION AND SOIL EROSION:

Siltation and soil erosion must be minimized during construction. See Section 02260 of these Specifications.

SEWER TRENCH EXCAVATION:

General: Under this section is included the removal and disposal of all materials, in both open cut and tunnel excavations, necessary for performing the work as shown on the Drawings or called for in the bid or addenda, including sheeting and bracing, drainage and other work incidental to the preparation of the site for sewer pipe installation.

Drainage: The Contractor shall make provisions for handling all flows in existing creeks, ditches, sewers and trenches by pipes, flumes or other approved methods always when his operations would, in any way, interfere with the natural functioning of said creeks, ditches, sewers, and drains. The Contractor shall at all times during construction provide and maintain sufficient equipment for the disposal of all water which enters the excavation, both in open cut trenches and in tunnels, to render such excavation firm and dry, until the structures to be built thereon are completed, at no additional cost to the Owner.

Excavated Materials: Materials of excavation shall include whatever materials are encountered to the depth shown on the Drawings, or as directed by the Engineer.

Disposal of Unsuitable Materials: Excavated materials which are either surplus and not required or are unsuitable for backfilling shall be removed from the site of operations as soon as excavated. All excavated materials so removed shall be disposed of at locations obtained by the Contractor. The Contractor shall secure written permission from the property owner(s) and furnish the Engineer with a copy of the agreement(s) upon request.

Storage of Suitable Materials: Excavated materials suitable and required for backfill shall be stored in neat piles adjacent to the excavation in a manner so as to interfere as little as possible with traffic, but shall not be placed at such heights above or closeness to the sidewalls of the excavation to endanger such operations due to slides or cave-ins.

Open-Cut Excavation: Open-cut excavation, either in earth or rock, shall be safely supported and of enough width and depth to provide adequate room for the construction or installation of the work to the lines, grades and dimensions called for by the Drawings. Trenches may remain open overnight providing applicable safety precautions are taken meeting OSHA and other applicable regulations.

Trench Dimensions: Excavations for sewer pipe in both earth and rock shall have a minimum and maximum allowable trench width below the outside top of the sewer pipe as shown on the Drawings, and for gravity sewers shall be carried to a specified depth below the outside diameter of the pipe, hereafter called the sub-grade, so as to permit the placing of the sewer and appurtenances at the specified elevations on the bedding or encasement material.

Depth of pipe, for payment purposes, shall be measured from bottom of pipe to top of ground.

1. Allowable Width:
   The required width of the trench will vary according to the size of the sewer pipe to be installed, as shown on the drawings. If the maximum allowable trench width 12" above the top of the sewer pipe is exceeded, a higher strength classification of sewer pipe of enough strength for that particular trench width will be required, at no additional cost to the Owner.

2. Sub-Grade:
   The required depth of sub-grade below the outside diameter of the sewer pipe will be 6 inches in rock and 4 inches in earth, unless otherwise directed.

3. Unsuitable Foundation:
   When the bottom of the excavation is unsuitable as a foundation, it shall be excavated below sub-grade and then refilled with concrete or compacted crushed stone to the sub-grade as the Engineer may direct. Such authorized work shall be paid for as set forth under the appropriate item of the Bid.

4. Unauthorized Excavation:
   Unauthorized excavation below sub-grade shall be filled with crushed stone or concrete as ordered and directed by the Engineer at no additional cost to the Owner.

Rock Excavation:

1. Solid rock excavation is defined as follows:
   a. Excavation of rock which cannot be economically excavated without the use of explosives.

   b. Any rock, boulder, fragment of rock or concrete having a volume of at least one-half (2) cubic yard or a fragment excavated from a formation having a volume greater than one-half (2) cubic yard.

2. When rock is encountered in open cut excavation, it shall be removed by drilling, blasting, digging or other approved methods so that the open cut trenches conform with the lines, grades and dimensions shown on the Drawings. The Contractor shall notify the Engineer prior to removal of any rock.

3. Blasting:
When blasting is required for the removal of rock, every precaution shall be used for the protection of persons and private and public property. Each blast shall be well covered with mats or other suitable means to confine the rock fragments within the excavation. Only the minimum amounts of explosives shall be used; no excessive charges will be permitted. Blasting shall be performed at a safe distance ahead of the installation of the sewer and structures to prevent damage to them as the work progresses. Blasting of rock for property service connections, T-branches, Y-branches, and studs shall be performed at the same time as the sewer trench blasting. The rock connections shall be shattered by continuing the drilling and blasting operations 6 feet beyond the end of the sewer, branch, stub or property service connection. Except with written permission and approval of the Engineer, no blasting of rock will be permitted at nights or on Sundays. Contractor is required to have pre-blast surveys done of structures near blasting sites.

4. Unauthorized Excavation:
If, for any reason, rock is excavated beyond the necessary limits as shown on the Drawings, such unauthorized excavation, or over breakage, shall be refilled with crushed stone or concrete as directed by the Engineer, at no additional cost to the Owner.

5. Rock and Backfill:
All excavated rock permitted to be used for backfilling purposes shall be used in accordance with these Specifications. All rock specified as unsuitable for backfill shall be removed from the site of the work at no additional cost the Owner.

SHEETING & BRACING:

General: The Contractor shall furnish, place and maintain adequate sheeting and bracing as may be required to support the sides of the excavation and prevent any movement of earth which could, in any way, diminish the width of the excavation to less than that necessary for proper construction, cause damage to the sewer or structure being constructed or to adjacent structures, utilities, pavements or walks, or cause injury to workmen or others through movement of the adjacent earth banks, or to otherwise damage or delay the works.

Supports: Sheeting may be of wood or steel and shall be of adequate strength for the excavation.

Methods: Wherever possible, the sheeting and bracing shall be driven ahead of the excavation to avoid loss of material from behind the sheeting. If it is necessary to excavate below the sheeting, care shall be taken to avoid trimming behind the face along where the sheeting will be driven. Care shall be taken to prevent voids outside the sheeting; but, if voids develop, they shall be immediately filled with selected sandy materials and compacted as directed by the Engineer.

Where drop inlets or stacks are constructed, the trench excavation shall be offset, as required, without additional compensation.

Left-in Place: The Engineer may order sheeting and bracing to be left in place at locations other than shown on the Drawings. Sheeting left in place may be ordered to be cut off at any specified elevation, but in no case shall it be left in the ground above an elevation 18 inches below the existing or proposed surface of the ground. All voids created by the cutting of the sheeting to be left in place shall be immediately filled with selected sandy materials and compacted as directed by the Engineer.

Sheeting and bracing left in place in open cut trenches as shown on the Drawings or as ordered by the Engineer shall be paid for under the appropriate items of the Bid. If the Contractor elects not to remove certain sheeting and bracing, he will not be paid additionally for such sheeting and bracing left in place. Any sheeting left in place at the Contractor's option must be approved by the Engineer.

Not Left-in Place: All sheeting and bracing not to be left in place shall be carefully removed (after the backfill is complete) to not endanger the sewers and other structures. All voids created by withdrawal of the sheeting shall be immediately filled with selected sandy materials and compacted as directed by the Engineer.

OPEN-CUT PIPE LAYING:

Gravity Sewer Pipe: After the trench is excavated to the subgrade specified, it shall be filled to grade with crushed stone, sand, or concrete as specified to provide a firm and satisfactory bed, for the entire length of the sewer pipe barrel. Pipe of the designated class and required size shall be laid to form a closed joint with the next adjoining pipe, bringing the inverts continuously to the required line and grade shown on the drawings. The pipe shall be laid in an upstream direction, with bells upstream, unless otherwise permitted or directed.

Force Main Pipe: Pipe shall be laid on the completed trench excavation and bedding (as illustrated by details) to the required grade and alignment.

Fittings and valves shall be located at the plan location with all joints centered, spigots home, and valve stems plumb.

Jointing: All joints shall be watertight, and any leaks or defects discovered shall be immediately repaired to the satisfaction of the Engineer. Any pipe which has been disturbed after being laid shall be taken up, the joints cleaned, and the pipe properly re-laid. Damaged or unsound pipe or fittings will be rejected. Before jointing the pipe, all lumps, blisters, excess coating material, and any dirt or sand shall be removed from the bell and spigot ends of pipes. Any superfluous material inside the pipe shall be removed by means of an approved follower or scraper after joints are made.

Factory-made joint materials shall be utilized. Installation shall be accomplished in strict accordance with the manufacturer's recommendations and with approval from the Engineer.

In no case shall water be allowed to rise in or above the pipe before the joint has become

thoroughly set. No walking on or working over the pipe after it has been laid, except as may be necessary in placing and compacting the backfill, will be permitted until the pipe is covered with backfill to a depth of 24 inches.

No direct payment shall be allowed for this item.

Joint for Ductile Iron Pipe: When lowered into the trench, the spigot, bell and gasket shall be cleaned in accordance with the manufacturer's recommendations. The pipe shall be pushed home and the gasket pressed firmly and evenly around the entire socket. The gland then pushed up to the bell and centered on the spigot of the pipe. Glands for large diameter pipe may require a wedge under the top side to assist in centering the gland lip against the gasket. The bolts are then inserted and tightened with the fingers until all are even. The bolts shall then be tightened as recommended by the manufacturer. Concrete shall be of composition specified within Section 03001. The sewer pipe shall be laid and supported in accordance with the Specifications for sewer pipe on a concrete cradle, as heretofore specified, and the concrete deposited around the pipe at the required width and depth to a plane at least 6 inches over the top of the pipe, as indicated on the Drawings. Proper bracing of the pipe shall be provided to prevent its being floated by the concrete encasement.

CONNECTING TO MANHOLES:

Tie-Ins to Existing Manholes: Tie-ins to existing manholes shall be constructed where indicated on the Drawings. The Contractor shall submit in writing to the Engineer for approval, the method of tying into existing manholes. The pipe shall be supported by tamped bedding, the degree of compaction of which is subject to approval by the Engineer. The space between the pipe and manhole wall shall be grouted to be watertight. The connection area shall not be backfilled until the grouting has dried and has been approved by the Engineer.

Connecting to Manhole: All connections made to manholes which are a part of this contract, shall be made using a Kor-N-Seal joint, or equal. This includes all pressure pipe, gravity pipe and force main. For pipes with diameter less than or equal to 4", the boot can be 4" diameter and a reducer fitting can be utilized. In manholes where pressure pipe enters at an elevation greater than two feet from top of invert, a 90^{o} fitting shall be utilized and a pipe shall be installed parallel to manhole wall extending from point of entry to elevation within two feet of top of invert.

CRADLE AND ENCASEMENT:

General: The cradle or encasement, as required to support and protect the sewer pipe, shall be installed as specified herein, as directed, or as necessitated by the Contractor's operations.

Crushed Stone or Sand Cradle: Where the sewer pipe is to be laid in a crushed stone cradle, the crushed stone shall meet requirements for Class "B" aggregate, Grading "D" as defined by current Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction. Sand will be permitted in lieu of crushed stone for cradle for service pipe. The crushed stone (or sand) shall be deposited in the excavated trench to grade, allowing for the sewer pipe wall thickness and providing "bell holes" for making joints where pipe is of the bell and spigot type. The sewer pipe shall be accurately laid to line and grade, and then crushed stone (or sand) shall be carefully deposited and tamped around the pipe up to a plane through

the springline of the pipe, as indicated on the Drawings.

Concrete Encasement: If the sewer pipe to be laid will have less than 2 feet of clearance between it and an existing or proposed storm drain or utility conduit, or if it is to be located within a street right-of-way and will have less than 3 feet of cover, concrete encasement shall be required to protect the sewer pipe. The length of sewer pipe to be encased shall be at least 2 feet beyond the outside diameter of the aforementioned storm drain or utility conduit, as directed. Concrete shall be of composition specified within Division 3. The sewer pipe shall be laid and supported in accordance with the Specifications for sewer pipe on a concrete cradle, as heretofore specified, and the concrete deposited around the pipe at the required width and depth to a plane at least 6 inches over the top of the pipe, as indicated on the Drawings.

Proper bracing of the pipe shall be provided to prevent its being floated by the concrete encasement.

Concrete Cradle: Where a concrete cradle is required as additional support for the sewer pipe, concrete shall be of composition specified within Division 3. The sewer pipe shall be laid accurately to line and grade, setting the pipe upon concrete blocks or saddles installed to provide both vertical and lateral supports for the pipe. The supporting of pipe on wooden blocks will not be permitted. Concrete shall be deposited around the pipe at the required width and depth up to a plane through the springline of the pipe, as indicated on the Drawings.

JOINT MATERIALS:

The Contractor must exert every reasonable effort to secure a watertight joint and prevent infiltration of groundwater into or exfiltration of sewage out of all pipe sewer and property service connections. To achieve this, joint material shall be made of the materials as specified herein, unless otherwise set forth in the Drawings, contract documents, or addenda. Any joint materials found to be defective or not meeting the Specifications shall be rejected and replaced by approved joint materials at no additional cost to the Owner.

SEPARATION OF WATER MAINS AND SEWERS:

General: The following factors should be considered in providing adequate separation:

(1) Materials and type of joints for water and sewer pipes;
(2) Soil conditions;
(3) Service and branch connections into water main and sewer line;
(4) Compensating variations in the horizontal and vertical separations;
(5) Space for repair and alterations of water and sewer pipes;
(6) Off-setting of pipes around manholes.

Horizontal Separation: Whenever possible, sewers should be laid at least 10 feet horizontally from any existing or proposed water main. Should local conditions prevent a lateral separation of 10 feet, a sewer may be laid closer than 10 feet to a water main if:

(1) It is laid in a separate trench, and if
(2) The elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.

Vertical Separation: Whenever sewers must cross under water mains, the sewer shall be laid at such elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirement, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint pipe for a distance of 10 feet on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.

Other Protection: When it is impossible to obtain proper horizontal and vertical separation as stipulated above, both the water main and sewer shall be constructed of mechanical-joint ductile-iron pipe and shall be pressure-tested to assure water tightness.

Sewer Manholes: No water pipe shall pass through or encounter any part of a sewer or sewer manhole.

PROPERTY SERVICE GRAVITY CONNECTIONS:

4" diameter service lines shall be provided where noted on the Drawings. Larger diameter service lines are required where indicated on drawings. Additional service connections may be required as designated by the Engineer.

The bar shall be within 1 foot of the finished grade surface. All service lines shall be marked with a 2" x 2" wooden stake, extending from the end of the service pipe to 6" above the ground surface.

SEWER APPURTENANCES:

General: Appurtenances to the sewer shall be provided and laid in accordance with the Drawings and in the manner as specified herein.

Branches and Fittings: Branches and fittings shall be provided and laid as and where directed. T-branches and Y-branches, placed in the sewer for property service connections, shall be located by the Contractor, as directed by the Engineer.

Stubs: Stubs for future sewer pipes shall be installed as indicated on the Drawings. If the specified length of the stub is exceeded, there will be no additional cost to the Owner unless the extra length is ordered by the Engineer. Existing sewer pipe stubs shall be removed as required, but only when directed by the Engineer.

Drop Inlets: At any manhole where the invert elevation of the incoming sewer is greater than or equal to 2 feet above the invert elevation of the outgoing sewer, an outside drop connection shall be made as indicated on the drawings. It shall consist of a vertical pipe riser connected to a tee on the incoming sewer and to the manhole with a 90° bend. The riser shall be protected by concrete. Outside drop connections shall be installed at the locations shown on the drawings and/or as directed by the Engineer.

Risers:
Where the street sewer lies at a depth greater than or equal to ten feet below the finished surface, or where directed by the Engineer, the Contractor shall construct 6" vertical pipe risers

for the purpose of keeping the trenches for the house services to a maximum of eight feet deep. The method for constructing a pipe riser is indicated on the Drawings. Such pipe risers shall be encased in concrete. The pipe and fittings used in the risers shall meet the Specifications provided for sewer pipe and pipe joint materials.

Valves, Clean out, Boxes & Fittings: All valve and cleanout boxes shall be furnished and installed as indicated on the plans. The boxes shall be firmly supported and shall be kept centered and plumb over the valve(s) or cleanout. The box cover shall be flush with the surface of the finished pavement or any other level designated by the Engineer.

Boxes for clean out shall be Davis Meter & Supply No. D-112 traffic type boxes, or equal.

Boxes for valves shall be Davis Meter & Supply plastic 5 1/4" roadway valve boxes No. 5-155-24 or no. 5-155-36 (as needed for trench depth), or equal. No. 6 round bases, or equal, are to be furnished with these boxes for valves larger than 2". Lids shall be 4-pronged traffic type. All boxes installed in areas that are unpaved shall have full flanged cast iron rings. The word "Sewer" shall be on the top of each lid. Extended stems shall be provided (from valve to surface) with centering inserts for all buried valves.

Boxes for air release and air and vacuum valves shall use standard pre-cast manholes, concrete, or equal. They shall have concrete top with frame and cover. The lids shall have the word "Sewer" on top. All boxes are to be installed outside of traffic areas.

Drainage branches or blow-offs shall not be connected with any sewer or submerged in any stream or be installed in any other manner which will permit back siphonage into the distribution system. Pipe and fittings inside clean-outs, air release valve and air and vacuum valve boxes shall be Schedule 40 steel pipe and shall be painted with one coat of Sherwin-Williams Metallic II Enamel or equal prior to installation including the threaded surfaces. The fittings used for joining the steel pipe to the main sewer line shall be Schedule 80 PVC and shall have threaded and O-Ring joints. No glue joints will be permitted.

Setting Other Devices: Check, relief valves or any other appurtenances required in connection with the mains or their appurtenances shall be installed in accordance with applicable Specifications applying to other valve fittings, and subject to any further detailed requirements included in the plans.

Plugging Dead Ends: Standard plugs shall be inserted into the bells of all dead-end fittings. Spigot ends shall be capped. Thrust blocking shall be provided at all dead ends of pipe that are capped or plugged.

ANCHORAGE OF BENDS, TEES AND PLUGS:
All pipelines, all plugs capped and bends equal to or exceeding 22 ½ degrees shall be securely anchored by thrust blocking as indicated in the standard Drawings. In addition, all tees shall be similarly anchored. Thrust blocking shall be concrete of a mix not leaner than 1-part cement, 2½ parts sand, 5 parts stone and a compressive strength not less than 2,000 pounds per square inch. Quantities of concrete required for different bends, tees, and valves shall be as indicated on the standard Drawings. If permitted by the Engineer, metal harness rods and pipe clamps of adequate strength to prevent movement may be used in lieu of concrete blocking.

MANHOLES:
Manholes shall be constructed where indicated on the Drawings or where designated by the Engineer, and shall be of concrete, either placed or pre-cast.

Wall: The outside surface of concrete manholes shall be coated with a layer of bitumastic, 10 mil dry thickness. Wall thickness shall be as specified within the Drawings. Backfill shall not be placed until this is thoroughly dried.

Base: The floor and invert of all manholes shall be built of concrete. Base sections shall be constructed upon a firm stabilized foundation. Inverts shall be constructed as shown within the Drawings and shall be of the same size and shape as the connected pipe. Steep slopes outside the invert channels shall be avoided. Changes in size and grade shall be made gradually and evenly. Changes in the direction of the sewer and entering branch or branches shall have a true curve of as large a radius as the size of the manhole will permit. Invert surfaces shall be smooth. Pre-cast inverts will be acceptable.

Watertightness: Manhole sections shall be jointed to be watertight. A rubber gasket of the quality indicated on the Drawings shall be utilized. Openings adjacent to the sewer pipe connections and all other joints in manholes shall be mortared to be watertight.

Backfill: Backfill around manholes and under pipes entering and exiting manholes shall be mechanically tapped.

SEWER PIPE BACKFILL:
General: Under this section is included the filling of the excavation trenches and spaces around the completed structures, in both open cut and tunnel excavation, to the original grades, unless otherwise shown on the Drawings.

Open Cut Backfills: Backfilling of excavated trenches in open cut shall commence as soon as possible after the sewer pipe is laid and the jointing and alignment are approved, but not until authorized by the Engineer.

Materials: The following materials shall be used to backfill the trenches in accordance with and in the manner indicated by the requirements specified herein:

1. Stone: Backfill in trenches within the limits of existing or proposed paved surfaces or shoulders, where defined in the Drawings or authorized by the Engineer, shall be made with crushed stone, crushed slag or washed gravel meeting the requirements of the Tennessee Department of Transportation Standard Specifications. The backfill shall extend from the top of the bedding to the bottom of the existing or proposed paving base.

2. Selected Excavated Materials: Backfill in trenches for sewers, property service connections and catch basins leads shall be made with selected excavated materials taken from the trench excavation except where stone backfill is required.

   The selected excavated materials used from the top of the structure shall contain no rocks. The selected excavated backfill materials used between the plane 2 feet above

the top of the pipe or structure and one foot below the ground surface may include rock fragments taken from the excavation. In backfill containing rock, the maximum dimension along any axis of rock shall not exceed six inches, and all rock fragments shall be mixed with enough earth materials to eliminate all voids, subject to the approval of the Engineer. The amount of rock in the backfill shall not exceed 33% of the total backfill. Rock fragments and surplus earth materials not used in the backfill shall be removed from the site of the work at no expense to the Owner.

Compaction of Backfill: Backfill material shall be compacted as indicated on the Drawings or allowed by the Engineer.

Depositing Backfill: If materials for any method of backfilling is dumped, bulldozed, or dropped from a height exceeding 5 feet above the previously placed backfill, its fall shall be broken by timber grillage or other means acceptable to the Engineer to prevent possible damage to the sewer.

Backfill Around Manholes & Other Structures: Selected excavated materials or sandy backfill materials shall be placed in uniform layers around manholes or other structures and shall be compacted to the satisfaction of the Engineer.

Backfill Around Iron Pipes: Selected excavated materials composed of clay, sand, gravel or other materials non-injurious to iron pipe shall be used for backfilling within 24 inches of iron pipe. Cinders, rubbish and other materials which would be injurious to iron pipe shall not be used in such backfilling.

Additional Backfill Materials: Backfill materials required in addition to that which are available shall be purchased by the Contractor, subject to the approval of the Engineer, at no additional cost to the Owner.

LEAKAGE TESTS:

General:

The Contractor shall fully test all sections of sewer lines in accordance with the procedures to follow. The Contractor shall be responsible for certifying to the Engineer and Owner that the sewer lines meet the allowable air or infiltration/exfiltration limits. Where it is deemed necessary by the Engineer, the Contract may be directed to use a specific testing procedure and assume responsibility for the results thereof. All labor, materials and equipment used in testing procedures (including water) shall be furnished by the Contractor.

Hydrostatic Tests - Force Main Pipe: After pipe has been laid and backfilled, all newly laid pipe or any valve section thereof shall be subject to a hydrostatic pressure of not less than 150 psi. The duration of the pressure tests shall be two hours. Each valve section of pipe shall be slowly filled with water. While the pipe is being filled and before the application of the specified test pressure, all air shall be expelled from the pipe. Taps may be required at points of highest elevation. These taps are to be tightly plugged after completion of the test.

The test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. The pump, pump connections, gauges, and all necessary apparatus and labor shall be furnished by the Contractor. The Contractor shall calibrate the gauges in the presence of the Engineer.

A test shall be made only after a part or all of the backfilling has been completed and at least 36 hours after the last concrete thrust block has been cast with high-early-strength cement or at least seven (7) days after the last thrust block has been cast using standard cement.

Any cracked or defective pipes, fittings, or valves discovered during hydrostatic pressure tests shall be removed and replaced with sound material and the test repeated until satisfactory to the Engineer. No payment shall be made for the removal and replacement of defective pipes and appurtenances.

Allowable leakage shall not exceed the value reported on Table 1:

See Table 1 below:

Table 1. Allowable leakage per 1000 ft of pipeline* - gph†

Avg. Test Pressure psi	NOMINAL PIPE DIAMETER-in.																	
	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54	60	64
450	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60	9.56	10.19
400	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11	9.01	9.61
350	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58	8.43	8.99
300	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02	7.80	8.32
275	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72	7.47	7.97
250	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41	7.12	7.60
225	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03	6.76	7.21
200	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73	6.37	6.80
175	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36	5.96	6.36
150	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97	5.52	5.88

	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54	60	64
125	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53	5.04	5.37
100	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05	4.50	4.80

*If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.
Calculated based on Eq.1.

Allowable leakage. No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

In inch-pound units,

$$L = \frac{SD\sqrt{P}}{133{,}200}$$

Where:

L = allowable leakage, in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of the pipe, in inches
P = average test pressure during the leakage test, in pounds per square inch (gauge)

Air Test Procedure-Gravity Sewer: All branch fittings and ends of lateral stubs shall be securely plugged at each manhole. All stoppers shall be adequately braced when required.

Air shall be slowly supplied into the plugged pipeline until the internal air pressure reaches 4.0 pounds per square inch or 4.0 pounds per square inch greater than the average back pressure of any ground water that may submerge the pipe. At least two minutes shall be allowed for temperature stabilization before proceeding further.

The rate of air loss shall then be determined by measuring the time interval required for the internal pressure to decrease from 3.5 to 2.5 pounds per square inch.

The pipeline shall be considered acceptable if the time interval for the 1.0 psi pressure drop is not less than the holding time listed in the following table:

MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR PRESSURE TO DROP FROM 3.5 TO 2.5 PSIG

PIPE DIAMETER

SECTION Length (Ft.)	**6"**	**8"**	**10"**	**12"**	**15"**	**18"**	**21"**	**24"**	**27"**	**30"**

25	**11**	**18**	**23**	**27**	**32**	**36**	**45**	**54**	**63**	**72**
50	**21**	**36**	**45**	**54**	**63**	**72**	**90**	**108**	**126**	**144**
75	**32**	**54**	**68**	**81**	**95**	**108**	**135**	**162**	**189**	**216**
100	**42**	**72**	**90**	**108**	**126**	**144**	**180**	**216**	**252**	**288**
125	**53**	**90**	**113**	**135**	**158**	**180**	**225**	**270**	**315**	**360**
150	**63**	**108**	**135**	**162**	**189**	**216**	**270**	**324**	**378**	**432**
175	**74**	**126**	**158**	**189**	**221**	**252**	**315**	**378**	**441**	**504**
200	**84**	**144**	**180**	**216**	**252**	**288**	**360**	**432**	**504**	**576**
225	**95**	**162**	**203**	**243**	**284**	**324**	**405**	**486**	**567**	**648**
250	**105**	**180**	**225**	**270**	**315**	**360**	**450**	**540**	**630**	**720**
275	**116**	**198**	**248**	**297**	**347**	**396**	**495**	**594**	**693**	**792**
300	**126**	**216**	**270**	**324**	**378**	**432**	**540**	**648**	**756**	**864**
325	**137**	**234**	**293**	**351**	**410**	**468**	**585**	**702**	**819**	**936**
350	**147**	**252**	**315**	**378**	**441**	**504**	**630**	**756**	**882**	**1008**
375	**158**	**270**	**338**	**405**	**473**	**540**	**675**	**810**	**945**	**1080**
400	**168**	**288**	**360**	**432**	**504**	**576**	**720**	**864**	**1008**	**1152**
425	**179**	**306**	**383**	**459**	**536**	**612**	**765**	**918**	**1071**	**1224**
450	**189**	**324**	**405**	**486**	**567**	**648**	**810**	**972**	**1134**	**1296**
475	**200**	**342**	**428**	**513**	**599**	**684**	**855**	**1026**	**1197**	**1368**
500	**210**	**360**	**450**	**540**	**630**	**720**	**900**	**1080**	**1260**	**1440**

Infiltration Test-Gravity Sewer: An infiltration test shall be conducted when the ground is well saturated and when infiltration can occur. The pipe shall be plugged at the upper manhole of the test section. An approved recovering device shall be installed at the lower manhole of the test section. The amount of water flowing through the outlet during a 30-minute period shall be measured. Infiltration shall not exceed 25 gallons per inch-diameter per mile of pipe per day.

Exfiltration Test-Gravity Sewer: An exfiltration test shall be conducted when the ground is dry, and infiltration will not occur. The inlet of the lower manhole of the test section shall be plugged. The line and upper manhole shall be filled with water to the four-foot level, or to the top of a straight section if less than four feet. The water shall stand in the pipe for four hours, until all trapped air has escaped. After maximum absorption is reached, the upper manhole shall be filled to the original level. After 30 minutes a measurement in water level subsidence shall be made, and the difference converted to gallons. Exfiltration shall not exceed 25 gallons per inch-diameter per mile of pipe per day.

DEFLECTION TESTS FOR GRAVITY SEWER LINES:

Gravity pipe shall be tested for deflection before final acceptance when PVC pipe is used to ensure that vertical deflection requirements specified in these Specifications have been met. The testing shall be conducted after the backfill has been in place at least 24 hours. Testing shall be done by using an electronic deflectometer or rigid "Go-No-Go" device or other approved method.

VACUUM TESTING:

All manholes shall be vacuum tested as follows:

All lifting holes and exterior joints shall be filled and pointed with an approved non-shrinking mortar.

Manholes are to be tested immediately after assembly and before backfilling. No standing water shall be allowed in the manhole excavation which may affect the accuracy of the test.

All pipes and other openings into the manhole shall be suitably plugged in such a manner as to prevent displacement of the plugs while the vacuum is drawn.

Installation and operation of vacuum equipment and indicating devices shall be in accordance with equipment Specifications and instructions provided by the manufacturer.

The test head may be placed in the cone section of the manhole. The rim-cone joint is not usually tested.

A vacuum of 10 inches of mercury shall be drawn. The time for the vacuum to drop to 9 inches of mercury shall be recorded.

Acceptance for 4-foot diameter manholes shall be defined as when the time to drop to 9 inches of mercury meets or exceeds the following:

Manhole Depth	Diameter	Time to Drop 1" Hg
10 ft. or less	4 ft.	60 seconds
10 ft. to 15 ft.	4 ft.	75 seconds
15 ft. to 25 ft.	4 ft.	90 seconds

For manholes 5 ft. in diameter add an additional 15 seconds and for manholes 6 ft. in diameter, add an additional 30 seconds to the time requirements listed in the table above for four-foot diameter manholes.

OTHER TESTING:

All wet-well and all multi-sectional precast concrete structures shall be tested for watertightness using a hydrostatic or vacuum test. Man-ways, inspection parts, and other accessories should also be included in the test per ACI 350.1R, AWWA D100, ASTM C1244, or C1227, ASTM (1993), or latest requirements.

Watertightness Testing Procedure/Criteria for Precast Concrete Tanks

Standard	**Hydrostatic Test**		**Vacuum Test**	
	Preparation	**Pass/Fail Criterion**	**Preparation**	**Pass/Fail Criterion**
C1227, ASTM (1993)	Seal tank, fill with water, and let stand for 24 hours. Refill tank.	Approved if water level is held for 1-hour.	Seal tank and apply a vacuum of 2 in. Hg.	Approved if 90% of vacuum is held for 2 minutes.

PART 4- PAYMENT

Payment for all associated piping and services shall be included under the lump sum contract amount.

END OF SECTION 02730

SECTION 02733 – CUTTING AND PATCHING

PART 1 GENERAL

SUMMARY

This Section includes procedural requirements for cutting and patching.

SUBMITTALS

Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:

Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.

Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.

Products: List products to be used and firms or entities that will perform the Work.

Dates: Indicate when cutting and patching will be performed.

Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.

Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.

Architect/Engineer's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

QUALITY ASSURANCE

Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.

Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's/Engineer’s opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

PART 2 PRODUCTS

MATERIALS

General: Comply with requirements specified in other Sections.

In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 EXECUTION

EXAMINATION

Examine surfaces to be cut and patched and conditions under which cutting, and patching are to be performed.

Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.

Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

PREPARATION

Temporary Support: Provide temporary support of Work to be cut.

Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

PERFORMANCE

General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.

Concrete or Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

Excavating and Backfilling: Comply with requirements in applicable Division 2 Sections where required by cutting and patching operations.

Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.

Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall

coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

PART 4- PAYMENT

Payment for all associated cutting and patching services shall be included under the lump sum contract amount.

END OF SECTION 02733

SECTION 03001 - CONCRETE

PART 1 - GENERAL

WORK INCLUDED:

Form work, shoring, bracing and anchorage

Concrete reinforcement and accessories

Cast-in-place concrete

RELATED WORK:

The construction of the sub-grade, including compaction, is specified under Division 2. If the sub-grade is not in suitable condition at the time construction begins, it shall be put in proper condition by removing all unsuitable materials, backfilling all holes with well-compacted granular material, and bringing the surface to crown and elevation.

This Contractor shall build into the concrete work any recesses, inserts, anchors, sleeves, anchor bolts, etc. as required by all trades.

REFERENCES:

"Specifications for Structural Concrete for Buildings" ACI 301-84 (Revised 1987).

In addition to ACI 301-84, cast-in place concrete shall conform to ACI 305-R88 and ACI 306-R83 for Hot Weather Concreting and Cold Weather Concreting, respectively. The use of any methods described in ACI 305-R82 or ACI 306-83 shall be approved by the Engineer before implementation.

"Building Code Requirements for Reinforced Concrete", ACI 318-86.

"Standard Specification for Ready-Mixed Concrete", ANSI/ASTM C94-84.

ANSI C 311-77, "Standard methods of Sampling and Testing Fly Ash for use as an Admixture in Portland Cement Concrete".

ANSI C 618-80, "Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete".

ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement

ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement

ASTM C33 - Concrete Aggregates

ASTM C260 - Air Entraining Admixtures for Concrete

ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete

ASTM D2103 - Polyethylene Film and Sheeting

FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces

NOTE: The term "standard specifications" is used herein referring to ACI 301-84 (latest revision).

Materials and work shall conform to the requirements of standards, codes and recommended practices required in this section. A copy of all ACI references shall always be kept available at the job site .

TESTS:

Materials and operations shall be tested and inspected as work progresses. Failure to detect defective work shall not prevent rejection when defect is discovered, nor shall it obligate the Owner for final acceptance.

Submit proposed mix design of each class of concrete to Engineer for review and acceptance prior to commencement of work.

The Contractor shall, at his own expense, obtain compression strength tests for each 100 cubic yards or fraction thereof, of each mix design of concrete placed in anyone (1) day. Contractor shall mold and cure three (3) specimen shall be tested (ASTM C39) at 7 days for information. One specimen shall be tested at 28 days for acceptance. The remaining specimen shall be tested only if irregularities occur during the handling or testing of the previous two (2) specimens. Test results shall be submitted to the Engineer for review and acceptance.

One additional test cylinder will be taken during cold weather and be cured on site under same conditions as concrete it represents.

Strength level of concrete will be satisfactory if the following two (2) requirements are met: 1) the average of any three consecutive strength tests shall be equal to, or greater than, the specified strength, and 2) no individual strength test shall be more than 500 psi below the specified strength.

Inspection and testing of concrete as delivered to the job site, such as, tests for slump, air content, and any other tests deemed necessary will be performed at lease once a day during placement of concrete. Concrete for testing will be taken from random samples. No payment will be made for concrete used for testing.

SHOP DRAWINGS:

Submit shop drawings of reinforcing steel.

Indicate reinforcement sizes, spacings, locations and quantities of reinforcing steel, bending and cutting schedules, splicing, supporting and spacing devices.

PART 2 - PRODUCTS

FORM MATERIALS:

Conform to ACI 301.

Furnish formwork as required to complete work.

2 x 4 shall be minimum size wood bracing members including those members used as edge forms for slabs.

REINFORCING STEEL:

Reinforcing Steel: ASTM A615, 60 psi yield grade billet steel deformed bars; uncoated finish.

Welded Steel Wire Fabric: Plain type, ANSI/ASTM A185; in flat sheets or coiled rolls; uncoated finish.

CONCRETE MATERIALS:

Cement: ASTM C150, normal - Type 1 Portland, grey color.

Fine and Coarse Aggregates: ASTM C33.

Water: Clean and not detrimental to concrete.

ADMIXTURES:

Air Entrainment Admixture: ASTM C260.

Water-reducing, Set-controlling Admixture: ASTM C494-80. Type A (water-reducing and retarding), Type E (water-reducing and accelerating). If used, a qualified concrete technician employed by the manufacturer shall assist in proportioning concrete materials for optimum use, to advise on proper use of admixture and adjustment of concrete mix proportions to meet job site and climatic conditions. Field inspection by employee representative during concrete placement will be required.

Fly ash, conforming to ANSI/ASTM C618, Class F, except ignition loss, shall not exceed fifteen percent (15%) cement replacement or 1.25:1 fly ash to cement substitution ratio by weight.

ACCESSORIES:

Bonding Agent: Agent to bond new concrete to existing concrete shall be Sondbond epoxy resin system as manufactured by Sonneborn Building Products, Inc.

Vapor Barrier: ASTM D2103, 6 mil thick clear polyethylene film.

Grouts (Non-Shrink): EPI Top 100 (Celanese Coating Co.): COLMA0-DUR or SIKASTIX 370 (SIKA Chemical Corp.): FX-75 HYDROESTER BONDING AGENT (Fox Industries) and FEL-POXY 102 (FEL-PRO Building Products, Inc.).

Construction Joints: "Dayton" 24 gage galvanized steel screen joint as shown on the drawings and shall be backed by 2 x full depth.

Expansion joints shall be pre-molded of bituminous materials manufactured in accordance with the latest edition of ASTM standards. The joints shall run the full depth of the concrete. Non-extruding joint material shall be used in all exterior applications.

Form Release Agent: Colorless material which will not stain concrete, absorb moisture or impair natural bonding or color characteristics of coating intended for use on concrete.

Waterstop: Waterstop-RX (coiled rope containing sodium bentonite) or PVC understop, 3/8" x 12", ribbed with center bulb.

Anchors: Where permitted, shall be Hilti HVA Adhesive, or equal.

Pressure Relief Valves: Unless otherwise noted on the plans, pressure relief valves shall be furnished and installed as noted here. Actual location and elevation of each pressure relief valve shall be identified and noted on the concrete reinforced steel shop drawing submittals. Each exterior wall pipe location shall be covered with 1 cubic yard of #57 stone and a double layer of geo-synthetic filter fabric to separate the stone from the backfilled soil material.
Wall type pressure relief valves shall be 6” Trumbull 367-1002 or equal.
Floor type pressure relief valves shall be 6” Trumbull 367-1022 or equal.
Length of wall pipes shall be adjusted accordingly based on actual concrete wall/floor thickness.

CURING MATERIALS:

Water: Clean and drinkable.

Absorptive Mat: Burlap-polyethylene, 8 oz./S.Y., bonded to prevent separation during use.

Membrane Curing Compound: ASTM C309. Material providing water retention not exceeding loss of 0.55 kg/m_2 when tested in accordance with ASNI/ASTM C 156-80. Master Builders Masterseal or equal.

CONCRETE MIX:

Selection of Proportions: General - Concrete shall be composed of Portland Cement, 211.1-78 aggregate, water, fly ash, admixtures, and air-entraining admixture. Proportions of ingredients shall produce concrete that will work readily into corners and angles of forms, bond to reinforcement, without segregation or excessive bleed water forming on the surface. Proportioning of materials shall be in accordance with ACI 211.1-78, "Recommended Practice for Selecting Proportions for Normal, Heavy and Mass Weight Concrete".

Concrete mix for each strength of concrete required shall be submitted to Engineer for approval.

(1) Proportions of ingredients shall be selected by past field experience or, in lieu of past performance, laboratory trail mixes to produce placability, durability, specified strength and properties specified.

(a) Maximum water-cement ratio: 0.43

(b) Minimum cement content: 620 lbs./CY

Coarse Aggregate No.	# per C.Y.
467 (1-1/2" maximum)	517
57 (1" maximum) or 67 (3/4" maximum)	564

Compressive strength of all concrete: 28 days; 4000 PSI

Air Entrainment:

Concrete subject to exposure shall be air entrained. Total air content required (air-entrained and entrapped air) shall be:

Normal Max. Size Coarse Aggregate	Total Air Content
3/4" (19 mm)	7% +/- 1
1" (25 mm)	6% +/- 1
1-1/2" (38 mm)	5% +/- 1

(1) Air content shall be measured by ANSI/ASTM C 231-78, "Standard Test Method for Air Content of Freshly Mixed Concrete by Pressure Method".

(2) Maximum total air content on troweled flatwork receiving a surface

hardener shall be 3%.

Slump:

(1) 1" minimum

(2) Slabs, beams, walls, columns, 4" maximum

(3) Footings, 3" maximum

(4) Flowable concrete, with prior written approval from the Engineer, 8" slump, not to exceed 10".

Aggregate Size:

Maximum size of coarse aggregate shall not exceed:

(1) One-fifth narrowest dimension between forms.

(2) Three-fourths minimum clear spacing between reinforcing bars.

(3) One-third the thickness of slabs.

Temperature:

When concreting at temperatures above 35° F, the aggregates or water shall be heated or cooled if necessary, prior to being placed in the mixer so that the temperature of the resultant mixture will not be less than 50° F at the time of placement. If heating is required, the apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible occurrence of overhead areas which might injure the concrete.

When concreting is authorized at temperatures 35° F or less, the Engineer will require the water or the aggregates or both to be heated to not less than 70° F nor more than 150° F. The temperature of the mixed concrete shall be not less than 60° F nor more than 90° F at the time of placing.

STONE BASE:

Stone base for all slab-on-grade construction shall be minimum 6" compacted thickness unless otherwise specified in the Soils Report, shall be crusher run stone, Tennessee Department of Transportation, Class "B" aggregate, Grading "D", compacted to 75% of as-placed volume. Stone base under basin slabs shall be compacted per Soils Report.

PART 3 - EXECUTION

FORMWORK ERECTION:

Examine the drawings carefully and provide all recesses and all openings of the sizes and shapes required or as may be directed by the Engineer for the installation of all work requiring openings. Furnish all forms of the sizes and shapes necessary except where sleeves are specified under other sections of the specifications.

Section 4.1.3 of the standard specifications is revised to permit forms of footings to be omitted when the soil and the workmanship permit accurate excavation to size and if omission is approved by the Engineer.

Removal of forms shall be done in a manner which will assure complete safety of the structure. In no case shall the supporting forms or shoring be removed until the members have acquired enough strength to support their weight and the loads thereon safely. Remove forms of exposed concrete carefully without injury to lines and edges.

REINFORCEMENT:

Place reinforcement and support to prevent displacement.

Reinforcing splices shall have minimum lap of 30 diameters.

All welded wire fabric shall be placed in accordance with Section 5.5.4 of the standard specifications.

PLACING CONCRETE:

Notify Engineer a minimum of 24 hours prior to commencement of concreting operations.

Unless authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40^{o} F, and not resumed until an ascending air temperature in the shade and away from artificial heat reaches 35^{o} F.

Preparation - Contractor shall provide access for delivery, provide access for delivery, provide enough equipment and manpower to rapidly place all concrete.

Formwork shall have been completed and snow, ice, water, debris removed from within forms.

Expansion joint material, anchors and all embedded items shall have been positioned.

Sub-graders shall be sprinkled sufficiently to eliminate water loss from concrete if vapor barrier is not required.

Install vapor barrier under all floor slabs on grade. Lap joints minimum 12 inches. Install one layer of vapor barrier continuously under all slabs on grade. Turn up membrane at vertical surfaces full thickness of slab and lap separate strip of membrane to provide double thickness. Seal around all pipes and conduits penetrating the membrane in accordance with the membrane manufacturer's recommendations. Do not disturb vapor barrier while placing reinforcement.

All exterior construction joints must have a water stop installed when the construction joint is below grade.

Concrete shall not be placed on frozen ground.

Conveying - Concrete shall be placed rapidly by methods to present segregation or loss of quality.

Placement - Concrete shall be deposited continuously or, when continuous placement is not possible, construction joints shall be located as approved by Engineer. Concrete shall be placed as nearly as possible to its final position. Avoid rehandling.

(1) Concrete shall be consolidated by vibration, spading, rodding, or forking. Work concrete around reinforcement embedded items and into corners; eliminate air or stone pockets and other causes of honeycombing, pitting or planes of weakness.

(2) Internal vibration shall have a minimum frequency of 8000 v/min. with amplitude to consolidate effectively.

(a) Vibrators shall be operated by competent workmen.

(b) Use of vibrators to transport concrete will not be allowed.

(c) Vibrators shall be inserted and withdrawn approximately every 18 inches for 5 to 15 seconds each time.

Saw cut control joints at an optimum time after finishing. Cut slabs with 3/16" thick blade, cutting 1/4 of depth of slab thickness.

Separate exterior slabs on grade from vertical surfaces by turning up poly V.B.

Sections of walls shall be a maximum of 30 feet between construction joints with placement within each section made continuously to produce a monolithic unit. At least 48 hours should elapse between castings of adjoining units.

Wall sleeves shall be used in locations where piping and conduits pass through concrete walls and shall be caulked watertight.

FINISHES (CAST-IN-PLACE STRUCTURES):

Finish for walks and curbs shall be broom finish.

Interior slabs shall receive a steel troweled finish. This does not apply to slabs inside basins, but to slabs inside buildings.

All formed concrete shall be "smooth form finished" at a minimum as defined by Section 10.2.2 of ACI 301-72. In addition, all interior concrete surfaces and exposed-to-view exterior concrete surfaces shall receive a smooth-rubbed finish. All tie holes and defects shall be patched, and fins completely removed. Cementitious coatings where specified shall be XYPEX Concrete, Vandex BB75 or Thoroseal.

Provide cementitious coating to the exterior wall surfaces of the cast-in-place structures as noted on the plans and/or specifications. Two coats shall be provided. Coverage shall extend 6” below finished grade elevation.

TOLERANCES:

Surfaces which are to receive troweled finish or broom finish shall be built to a true plane within 1/8 inch in 10 feet as determined by a 10 foot straightedge placed anywhere on the slab in any direction.

Surfaces which are to receive scratched finish or floated finish shall be built to a true plane within 1/4 inch in 10 feet as determined above.

CURING AND PROTECTION:

Immediately following placement, concrete shall be protected from premature drying, hot and cold temperatures, rain, flowing water and mechanical injury.

Material and method of curing shall be approved by Engineer. Final curing shall continue for not less than 7 days.

(1) Approved methods include: Ponding or continuous sprinkling, continuous wet mats, sand kept continuously wet and liquid membrane-forming compounds.

(a) Applications of waterproof sheet material shall conform to ANSI/ASTM C 171-69 (Re-approved 1975), "Standard Specification for Sheet Materials for Curing Concrete".

(1) Material shall maintain a maximum moisture loss of 0.55 kg/m2 tested in accordance with ASTM/ASTM C 156-80, "Standard Test Method for Water Retention by Concrete Curing Materials".

b) Application of membrane-forming compounds shall conform to

ANSI/ASTM C 309-81, "Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete", "Master-Seal", manufactured by Master Builders.

CONCRETE GROUT:

Grout shall be mixed in quantities as needed and shall not be retempered or used after it has begun to set. The grout shall consist of one-part Portland Cement (Portland Cement, AASHTO Spec. M-85) and two parts sand by volume mixed with enough water to form a grout of proper consistency. When non-shrinking or non-shrinking fast-setting grout is used, it shall be formulated by the incorporation of an admixture, or a pre-mixed grout may be used. The formulation and the admixture or the pre-mixed grout used will be subject to the approval of the Engineer and shall be mixed and used in accordance with the recommendations of the manufacturer. Water for the grout shall be clean and free from silt or suspended solids. Bonding agent shall be used to bond grout to existing concrete.

PART 4 - PAYMENT

All concrete work shall be included and paid under the lump sum contract amount.

END OF SECTION 03001

SECTION 03050 – UNDER-SLAB VAPOR BARRIER

PART 1 GENERAL

PART 2 PRODUCTS

MATERIALS

Under slab Vapor Barrier:

Water Vapor Permeance: Not more than 0.010 perms (0.6 ng/(s m2 Pa)), maximum.

Thickness: 15 mils (0.4 mm).

Basis of Design:

> Stego Industries LLC; Stego Wrap Vapor Barrier (15-mil), or equal: www.stegoindustries.com.

Accessory Products: Vapor barrier manufacturer's recommended tape, adhesive, mastic, etc., for sealing seams and penetrations in vapor barrier.

PART 3 EXECUTION

INSTALLATION

Install vapor barrier in accordance with manufacturer's instructions and ASTM E1643.

Install vapor barrier under interior slabs on grade; lap sheet over footings and seal to foundation walls.

Lap joints minimum 12 inches.

Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions.

No penetration of vapor barrier is allowed except for reinforcing steel and permanent utilities.

Repair damaged vapor retarder before covering with other materials.

PART 4- PAYMENT

All services shall be performed and included under the lump sum contract amount.

END OF SECTION 03050

SECTION 03100 - CONCRETE FORMWORK

PART 1 - GENERAL

Related Documents: Drawings and general provisions of Contract, including General and Supplementary General Conditions and Division 1 Specification Sections, apply to work of this Section.

Summary: The extent of formwork is indicated by the concrete structures shown on the Contract Drawings. Work shall include (except as specified elsewhere in the Contract Documents) providing formwork and shoring for cast-in-place concrete; and installation of items furnished by others into formwork such as anchors, plates, inserts, frames, nosings, and any other items embedded in concrete. Form openings for penetrations such as mechanical, electrical and architectural work.

RELATED WORK SPECIFIED ELSEWHERE:

Cast-In-Place Concrete: Elsewhere in Division 3

Concrete Reinforcement: Elsewhere in Division 3

QUALITY ASSURANCE:

Codes and Standards: Current editions of the following references shall apply to work of this Section except as otherwise specified herein.

Publications of the American Concrete Institute:

ACI 347 "Recommended Practice for Concrete Formwork"

ACI 301 "Specification for Structural Concrete for Buildings"

ACI 117 "Standard Tolerances for Concrete Construction and Materials"

Qualifications of Workmen: Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials being installed, the referenced standards and the requirements of this work, and who shall direct work performed under this Section.

SUBMITTALS:

Product Data and Manufacturer's Printed Installation Instructions: Submit Manufacturer's specifications and installation instructions for proprietary materials and items as required, including form coatings, form materials, manufactured form systems, ties, accessories, formwork facing material, jointing, reveals, chamfers, etc.

Reshoring: Submit Contractor's sequence, locations, and placement of shores and reshores. Load capacity of shores shall be shown on this submittal.

PART 2 - PRODUCTS

FORMWORK MATERIALS:

Exposed Concrete Surfaces:

Formwork for exposed concrete surfaces shall be constructed with high quality plywood materials or other approved materials to obtain a smooth, straight, non-yielding surface. Form plywood shall be a resin overlay type similar to Burke-Neotex, Fin Form, or have a polyurethane or similar coating sufficiently heavy to prevent transfer of wood grain and to fill and cover plugs and defects in the plywood. Plywood forms shall be constructed with 4' x 8' minimum size sections of plywood to minimize the number of joints in the formwork.

Joints in the plywood and around holes shall be cleaned of release agents residue and sealed with a 2" wide vinyl or polyester film tape similar to 3M Number 351 Scotch parafilm to prevent leakage of water and grout at the joints. In lieu of a tape, a continuous silicone sealant may be used along the joints to seal joints in the formwork. Joints shall be continuously sealed to prevent any leakage of water or grout.

Unexposed Concrete Surfaces: Shall be formed with plywood not less than 5/8" thick, 5-ply Douglas Fir plywood conforming to PS 1, and as manufactured by a member of APA; B-B Plyform, Class I, EXT-APA, or equal.

Form Ties: Provide factory-fabricated, adjustable-length, non-leaking metal form ties with plastic cones for all exposed concrete walls. The ties shall be designed to prevent form deflection and to prevent spalling of concrete surfaces upon removal. Snap-off metal ties designed to prevent form deflection and to prevent spalling of concrete surfaces upon removal may be used for concrete that is not exposed. Plastic cones on snap ties shall be a type that places the portion remaining within concrete (after removal of exterior parts) at least 1-1/2" from outer surface of concrete. Twisted wire ties or band iron will not be permitted.

Form Coating: Provide commercial formulation of form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces; and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion; nor impede wetting of surfaces to be cured with water or curing compounds.

Form-facing materials: Shall be such as to provide specified surface tolerances and finishes, and to meet requirements of Section 2 of ACI 301.

PART 3 - EXECUTION

EXAMINATION:

General: Prior to work of this Section, carefully inspect the site and the installed work of all other trades and verify that such work is complete to the point where this installation may properly commence in accordance with the requirements shown on the drawings and specified herein. Verify that forms may be constructed in accordance with pertinent codes and regulations, the referenced standards, and the requirements of these Specifications. In the event of discrepancy, immediately notify Architect. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

DESIGN OF FORMWORK:

Design, erect, support, brace, and maintain formwork so that it will safely support vertical and lateral loads that might be applied until such loads can be supported by the concrete structure.

Contractor shall be responsible for the design and adequacy of formwork in its entirety. The design of the formwork shall meet the requirements of ACI 347 except as specified herein.

Thicknesses of formwork shall be sufficient to withstand pressure of newly placed concrete without bow or deflection. Bow or deflection of form-facing materials for exposed concrete shall not exceed L/600 of the span between supports.

Design formwork to be readily removable without impact, shock, or damage to concrete surfaces and adjacent materials.

Unless otherwise shown or specified, design, construct, erect, maintain, and remove forms and related structures for cast-in-place concrete work in compliance with ACI 347.

Support conveying equipment for placing concrete directly on formwork or structural member without bearing on reinforcing steel. Where cast finishes are required, materials which will impart a stain to the concrete shall not be applied to the form surface. Where finished surfaces are to receive coatings, materials applied to the form surfaces shall be compatible with the coatings.

Concrete in Earth: Where trench excavation is used, and where sides of excavations are cut neatly in good, firm soil, side-forms may be omitted.

Form Construction:

Forms shall be constructed to comply with requirements of ACI 347. Forms shall be to exact sizes, shapes, lines, and dimensions shown; and as required to obtain accurate alignment, location, grades, level, and plumb in finished structures.
Provide for openings, sleeves, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages, inserts, and other features required. Bevel, marker and rustication strips shall be applied in straight lines and well nailed to prevent displacement.

Form intersecting planes to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.

Provide openings in wood forms to accommodate other work, including mechanical and electrical work. Place accurately and support securely items required to be built into forms.

Drill forms to suit ties used, and to prevent leakage of concrete mortar around tie-holes. Do not splinter forms by driving ties through improperly prepared holes. Seal holes and openings in formwork for exposed concrete surfaces.

Do not use metal cover plates for patching holes or defects in forms.

Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Butt joints solidly and provide backup material at joints as required to prevent leakage and fins.

Fit forms (placed in successive units for continuous surfaces) to accurate alignment, free from irregularities, and within allowable tolerances.

Cleanouts, Cleaning, and Tightening: Provide temporary openings in forms as required to facilitate cleaning and inspection. Thoroughly clean forms and adjacent surfaces which will receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before concrete is placed. Retighten forms immediately after concrete placement (as required) to eliminate mortar leaks.

Formwork for Exposed Work: Construct forms for exposed work with 4' x 8' minimum size sheets of overlaid plywood to provide continuous, straight, smooth exposed surfaces. Use largest practicable size of plywood to minimize number of joints. Provide continuous watertight sealants for joints in plywood forms for exposed work using a 2" wide vinyl or polyester tape or applying a continuous seal with a silicone caulking. Provide chamfered corners at corners of exposed concrete. Joints shall be accurately cut, fitted, and sealed to prevent leakage of grout.

Formwork for Unexposed Work: For unexposed surfaces in finished structure, construct formwork with plywood, boards, metal, or other acceptable material.

Construction Joints: Forming material for flush surfaces exposed to view shall overlap hardened concrete of previous placement by a minimum of 1 foot.

Contact surface of form shall be held against hardened concrete sufficiently tight to prevent offsets or loss of mortar at joint, and shall maintain a true surface.

Form Coatings: Coat contact surfaces of forms with form-coating compound immediately before reinforcement is placed. Do not allow excess form coating to accumulate in forms or encounter reinforcing steel or embedded items. Apply in strict accordance with manufacturer's recommendations.

Embedded Items: Set and build into the work anchorage devices and other embedded items required for other work that is attached to or separated by cast-in-place concrete. Use setting drawings or instructions, and directions provided by suppliers of items to be attached thereto.

Form Removal:

Formwork not supporting the weight of wet concrete, such as sides of walls, columns, and similar parts of the work, may be removed 72 hours after placement of concrete, provided concrete is sufficiently hard so as not to be damaged by form-removal operations, and provided that curing and protection operations are maintained on newly exposed concrete for an additional 96 hours.

Circular column forms shall be removed within five days from casting unless otherwise approved by the form manufacturer.

Formwork supporting the weight of wet concrete shall not be removed until after concrete has attained a minimum of 75% of specified design strength. Compressive strength of concrete cured under field conditions shall be verified by the Contractor by methods acceptable to the Engineer prior to removing forms.

Shores and Reshoring: Shores and reshores shall extend at least three (3) levels below the floor level or roof where concrete is being placed. Always maintain a minimum of two (2) levels of shoring below the level where concrete is being placed. Locate shores directly under level being placed so that loads from construction above will be transferred directly to the shores at the level below. Space shores in the level below this level in such a manner that no level or member will be excessively loaded.

In general, shores at this level will be approximately 1/2 of the shores required at the level above. Extend shores below this level if required to insure proper distribution of loads throughout the structure. Shores and reshores shall be sized to safely support the loads from the wet concrete and construction loads at the level being constructed. Reshores cannot be removed until the concrete in the level placed has attained a minimum of 80% of its specified compressive strength.

Re-Use of Forms: Clean and repair surfaces of forms to be re-used in the work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable. Apply new form-coating compound to surfaces in contact with concrete as specified for new formwork.

Tolerances: Tolerances for formwork and resulting concrete shall conform to requirements of ACI 347 and ACI 117.

PART 4- PAYMENT

All services and materials shall be covered under the lump sum contract amount.

END OF SECTION 03100

SECTION 03200 - CONCRETE REINFORCEMENT

PART 1 - GENERAL

RELATED DOCUMENTS: Drawings and general provisions of Contract, including General and Supplementary General Conditions and Division 1 Specification Sections, apply to work of this Section.

SUMMARY: Reinforcement for cast-in-place concrete (including bars, welded wire fabric, ties, and supports) as shown on Drawings, and as specified herein.

RELATED WORK SPECIFIED ELSEWHERE:

Concrete Formwork: Elsewhere in Division 3

Cast-In-Place Concrete: Elsewhere in Division 3

QUALITY ASSURANCE:

Codes and Standards: Current editions of the following references shall apply to the work of this Section.

Publications of the ACI:

ACI 117	"Standard Tolerances for Concrete Construction and Materials"
ACI 301	"Specification for Structural Concrete for Buildings"
ACI 315	"Manual of Standard Practice for Detailing Reinforced Concrete Structures"
ACI 318	"Building Code Requirements for Reinforced Concrete"

Publication of the AWS:

AWS D1.4	"Recommended Practice for Welding Reinforcing Steel, Metal Inserts, and Connections in Reinforced Concrete Construction"

Publication of the CRSI: "Manual of Standard Practice"

SUBMITTALS:

Shop Drawings:

Shop drawings shall be prepared in accordance with ACI 315. Use of sepia transparencies of Contract Drawings for shop drawings will not be acceptable. Only shop drawings checked and stamped "Approved by Contractor and Fabricator" will be accepted for review. Show placing plans, bending details, and bar lists.

Show reinforcing for walls and grade beams in elevation views, with location of laps and accessories indicated clearly. Show reinforcing steel in plan views, with laps clearly shown and located. Show details, bar clearances, notes, and necessary information for placing of reinforcing steel.

Submit shop drawings in the form of one reproducible sepia and blue line prints for each sheet of shop drawings.

Reinforcing Test Reports: Furnish certified mill test reports on reinforcing steel used in work.

DELIVERY, STORAGE, HANDLING:

Delivery and Identification: Reinforcing steel shall be delivered to the project site properly tagged, bundled, and ready to place.

Protection: Reinforcing steel delivered to the project site shall be protected from mud, excessive rust-producing conditions, oil, grease, or distortion. Reinforcing steel shall be stored off ground on heavy timbers.

PART 2 - PRODUCTS

REINFORCING MATERIALS:

Reinforcing Bars: New, deformed bars, conforming to ASTM A615-S1 Grade 60, as required on Drawings.

Bar Mats: Bar mats for concrete reinforcement shall conform to the requirements of ASTM A184 "Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement."

Welded Wire Reinforcement: Welded plain wire reinforcement for concrete reinforcement shall conform to ASTM A185 "Specification for Steel Welded Wire Reinforcement, Plain, for Concrete Reinforcement" except that for wire with a specified yield strength exceeding 60,000 psi shall have a stress corresponding to a strain of 0.35 percent if the yield strength exceeds 60,000 psi. Wire for welded wire reinforcement shall be made of wire conforming to ASTM A82, "Specification for Steel Wire, Plain, for Concrete Reinforcement". Provide reinforcement in sheets.

Mechanical Splices: Where called for or specified on the Drawings, mechanical splices for reinforcing steel shall be a positive connecting threaded type with a coupler.

Splices shall meet the requirements of ACI 318. Bar ends shall be threaded with coupler manufacturer bar threads to ensure proper thread engagement. Bars shall be tightened to the manufacturer's recommended wrench setting. Mechanical splices shall be capable of providing an ultimate strength of 125% of the yield strength of the reinforcing steel.
Plain Smooth Dowels: Plain smooth dowels for construction joints in slabs on grade shall conform to ASTM A306.

Accessories: Fabricate from concrete, metal, plastic or other approved materials. Chairs or bolsters for use in exposed concrete shall have plastic-coated or stainless steel (AISI Alloy 302 or 304) legs.

PART 3 - EXECUTION

FABRICATION:

General: Reinforcing steel shall be fabricated to shapes and dimensions indicated on Drawings, and in compliance with applicable provisions of ACI 301 and ACI 318.

Field Bending: No bars shall be bent in field, unless specifically indicated on Drawings or approved in writing by the Architect.

Tolerances: Bars used for concrete reinforcement shall meet the following requirements for fabrication tolerances:

Sheared length: +/- one inch

Stirrups and ties: +/- one-quarter inch

All other bends: +/- one inch

PLACING OF REINFORCING STEEL:

General: Reinforcing shall be free from scale, loose rust, mud, or coatings which will reduce bond to concrete. Bars with kinks or bends not shown on Drawings shall not be placed. Heating of reinforcement for bending or straightening will not be permitted. Minimum concrete cover for reinforcing shall be as shown on Drawings. Bars shall not be bent after embedment in hardened concrete except as shown on the Drawings.

Tolerances: Bars shall be placed to the following tolerances:

Concrete cover to formed surfaces: ± one-quarter inch for members 8" deep or less and ± one-half inch for members deeper than 8"

Clearance to vertical form surface: ± one-quarter inch

Spacing of Bars: Minimum clear distance between parallel bars in a beam shall be equal to 1.5 times the nominal diameter of bar. In no case shall clear distance between bars be less than 1", nor less than 1-1/3 times maximum size of coarse aggregate. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter or enough to exceed tolerances required, resulting arrangement of bars shall be subject to approval by Engineer.
Accessories: Furnish approved bar supports over formwork. Where concrete surface will be exposed to weather in finished structure, or where rust would impair subsequent finishes, portions of accessories in contact with formwork shall be made of stainless steel or shall have plastic-coated legs. Nails shall not be driven into formwork to support reinforcement.

Standards: Space bar supports in accordance with ACI 315, ACI 301, and CRSI Manual of Standard Practice except as shown on the Drawings.

Securing Reinforcement: Reinforcing bars shall be supported and wired together to prevent displacement by construction loads or by concrete being placed, beyond tolerances as set forth hereinbefore. Maintain metal reinforcement securely and accurately in place until concrete is placed. Use bar bolsters on side-forms for concrete walls and piers.

Disturbances: Any disturbance of reinforcement shall be corrected fully prior to placement of concrete. Damaged bar-supports and spacers shall be repaired or shall be removed and replaced.

Column and Pier Dowels: To insure proper placement of column and pier dowels, plywood templates shall be furnished for dowels.

Welding: When approved in writing by the Architect, welding of reinforcing steel shall conform to AWS D1.4. Do not weld at bend in a bar. Welding of cross bars will not be permitted.

SPLICES OF REINFORCEMENT:

General: Splices and offsets in reinforcement shall not be made at points of maximum stress. Splices shall be approved. Splices shall provide sufficient lap to transfer required stress. Stagger splices of adjacent bars wherever possible. Character and design of each splice shall conform to requirements of ACI 318. Minimum splice shall be 36 bar diameters for reinforced concrete and 48 bar diameters for reinforced masonry.

MECHANICAL SPLICES:

General: Examine the threaded bar ends to make sure that they are undamaged and clean. If cleaning is required, use a wire brush. Damaged threads and couplers shall be rejected. Determine that the coupler is the correct size for the bar being spliced.

Installation: Screw the coupler to the end of the bar to be spliced and tighten by hand. Screw the second bar into the coupler and hand-tighten. Tighten each coupler with an inspection wrench furnished by the manufacturer. Tighten to the minimum required wrench setting value shown for the specific coupler size being installed.

FIELD QUALITY CONTROL:

Review of Placement of Reinforcing Steel: Engineer shall be given advance notice of not less than 24 hours prior to concrete placement to allow review of reinforcing steel. Any concrete placed without approval of Owner's representative will be subject to rejection. Review of placement of reinforcement in a section will be made only after placement is complete for that section to be poured. Such reviews shall not relieve the Contractor of his responsibility to provide work in accordance with the requirements of the Contract Documents. Such reviews are for purpose of minimizing errors in field work.

PART 4- PAYMENT

Payment for all the reinforcing steel and services shall be covered under the lump sum contract amount.

END OF SECTION 03200

SECTION 03370 - MEMBRANE FORMING CURING COMPOUND

PART 1 – GENERAL

SUMMARY

This Section includes membrane forming curing compounds for new construction.

RELATED SECTIONS

Concrete Paving
Cast-in-Place Concrete
Non-Shrink Grout

REFERENCES

American Society for Testing Materials:

ASTM C 309 Standard Specification for Membrane Forming Curing Compounds
ASTM C 1315 Standard Specification for Liquid Membrane-Forming Compounds, having special Properties for Curing and Sealing Concrete

PART 2 – PRODUCTS

MANUFACTURERS

Basis-of-Design Product: The membrane forming curing compound is based on products available products subject to compliance with requirements of the design basis product:

Basis of Design: Dress & Seal WB 25 as manufactured by L&M Construction Chemicals, Inc.; 14851 Calhoun Road, Omaha, NE 68152 Toll Free Technical

Assistance Line: 800-362-3331; website, www.lmcc.com http://www.lmcc.com/, or equal.

MATERIALS

Dissipating resin-based, membrane forming curing compound. Material will Degrade when exposed to ultraviolet light and abrasion, but care must be taken to completely remove the film mechanically prior to application of subsequent toppings or coatings. Complies with all local and state air quality regulations. Complies with ASTM C309, Type 1.

DRESS & SEAL

Non-yellowing acrylic cure-sealer-dustproofer. Conforms to ASTM C1315 Type 1, Class A. (Non- yellowing).

Second coat to be used as sealer coat.

Exterior Concrete pavement curing: White pigmented, membrane forming curing compound. Complies with all local and state air quality regulations and with ASTM C 309, Type 2

L&M CURE W2

PART 3 – EXECUTION

APPLICATION

Apply specified membrane forming curing compound to concrete after final finishing operations and concrete surface glaze has disappeared.

Concrete shall be protected from premature or excessive drying temperature extremes and damage immediately following finishing. Minimal moisture loss at relatively constant temperature shall be maintained.

Curing shall be maintained for a minimum of seven (7) days or until seventy (70) percent of the specified concrete strength has been obtained.

During curing period, concrete shall be protected from damage by equipment, temperature change, stored materials, jobsite activities, rain, and running water.

FIELD QUALITY CONTROL

Examine the curing compound work to determine if the concrete is suitably protected by the material.

PART 4- PAYMENT

Payment for this work shall be included under the lump sum contract amount.

END OF SECTION 03370

SECTION 05101 – STRUCTURAL METAL

PART 1- GENERAL

Applicable provisions of the General Conditions, Supplementary Conditions, and Division I, General Requirements apply to the Work under this Section.

SCOPE OF WORK

Work under this section includes all structural metal as defined here and noted under Section 05500 of this specifications.

The definition of structural metal shall be "Structural Steel" as defined in Section 2 of American Institute of Steel Construction Code of Standard Practice for Steel Buildings and Bridges.

Description of the Work: The extent of structural steel work is shown on the Drawings and includes furnishing, fabricating, delivering, and erecting structural steel shapes and anchor bolts; setting plans; headed stud-type shear connectors; shop cleaning; surface preparation and painting; touch-up painting in the field; and detail material as required to complete the job.

SHOP DRAWINGS

Submit complete shop drawings of all structural complete details and listings of the steel including shop and field connections' method of fabrication, finishes and relation to surrounding work. Submittals shall be sealed by a registered professional engineer in Tennessee. Engineer’s review of shop drawings will be for general purposes only.

APPLICABLE STANDARDS

Steel fabricators submitting bids on the work included in this Section shall be members of the AISC at time of bidding; and materials, fabrication, and erection except as specified otherwise shall be in accordance with the following American institute of Steel Construction (AISC):

Codes and Standards: Comply with the provisions of the following except as noted on the Drawings. However, no provisions of any referenced code or referenced standard or specification shall be effective to change the duties and responsibilities of Owner, Contractor, Engineer, or any of the Consultants, Agents, or Employees from those set forth in the Contract Documents, nor shall it be effective to assign to the Engineer or any of his Consultants or Agents any duty or authority to supervise or direct the furnishing or performance of the work or authority to undertake any responsibility for safety precautions or programs incidental to safety nor for the Contractor's failure to perform work in accordance with the intent of the Contract Documents.

AISC "Code of Standard Practice for Steel Buildings and Bridges"

AWS "Structural Welding Code"

AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings", including the "Commentary" and Supplements thereto as issued.
ASTM "The American Society for Testing and Materials"

Specifications for Structural Joists using ASTM A32S or A4GO bolts.

Cleaning and Painting shall be in accordance with Steel Structures Painting Council (SSPC) referenced specifications.

All welding shall conform to the requirements of the American Welding Society Code for Welding in Building Construction Dl.O-66. Provide certification that welders to be employed in the work have satisfactorily passed AWS qualification tests within the previous 2 years. Welders shall have been qualified in accordance with the requirements of D1.0-66. Those currently qualified and who are performing under the classifications necessary for their work will not be required to be requalified. Welders need only be qualified for those welding positions and welding processes in which they will be engaged.

Design of members and connections: Details shown are typical. Similar details apply to similar conditions, unless otherwise indicated. Submit proposed details for approval by the Engineer whenever design of members and connections for any portion of the structure is not clearly indicated in Contract Documents. The design of the connections shall be in accordance with the latest AISC Specifications and shall safely support the full dead and design live load reactions of the members.

DELIVERY, STORAGE AND HANDLING:

Delivery: Deliver materials to the site at such intervals to insure uninterrupted progress of the work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to not delay that work.

Storage: Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

Supports: Do not store materials on the structure in a manner that might cause distortion or damage to the members of the supporting structures. Repair or replace damaged materials or structures as directed.

Handling: Handle in a manner to prevent damage, distortion and excessive soiling of steel members.

PART 2- PRODUCTS

MATERIALS

Shapes: ASTM A36, A992, Grade 50

Rolled Steel Plates, and Angles: ASTM A36.

Steel Pipe: ASTM A53, Grade B.

Hot-Formed Steel Tubing: ASTM A500, Grade B.

High strength bolts and nuts shall conform to ASTM A325N.

Anchor bolts and other hardware shall be stainless steel and shall conform to ASTM F1554 GR Yield Strength 36Ksi, Headed.

Welding Electrodes: Conform to ASTM A233, Class E-70, Low-Hydrogen, AWS Code.

Headed Stud-Type Shear Connectors: ASTM A108, Grade 1015 or 1020, unpainted cold-finished carbon steel; uniform diameters and concentric heads normal to the shafts; chamfered and solid fluxed weld ends; with dimensions complying with AISC specifications designed for weld-through technique.

STRUCTURAL STEEL PRIMERS:

Products: Products of the following manufacturers will be acceptable for use on this project when approved by the Engineer and when the products meet all the requirements of these Specifications:

Carboline Company of St. Louis, Missouri
Sherwin-Williams of Strongsville, Ohio
Tnemec Company of North Kansas, Missouri, or equal

Shop Primer: Formulation of zinc-chromate and red iron-oxide in an alkyd vehicle unless otherwise noted. Solids (by volume) shall not be less than 42%. Color shall be red or brown. Total dry film thickness shall not be less than 2.5 mils. Each exposed exterior ferrous metal item shall receive a shop-applied prime coat of an inorganic zinc paint on its entire surface at a rate of 3.0 mils dry film thickness.

Touch-Up Coating: Same product as Shop Primer.

NON-METALLIC, NON-SHRINK GROUT:

Grout: Premixed factory-packaged non-corrosive, non-metallic high-strength grouting compound. Grout shall be Masterflow 928 as manufactured by the Master Builders, Inc., or Sonogrout as manufactured by Sonneborn Building Products, or equal.

PART 3- EXECUTION

FABRICATION

General: Fabricate items of structural steel in accordance with AISC "Specifications" and as indicated on the final shop drawings. Properly mark and match-mark all materials for field-assembly. Fabricate for delivery sequence which will expedite erection and minimize field-handling. Fabrication shall be complete before surfaces are prepared for painting.

Connections: A combination of bolts and welds in the same connection is not permitted unless otherwise detailed. Connections not detailed shall be designed for loads shown on Drawings or for loads given in Standard AISC Load Tables for spans, sections and strengths specified.

Shop Connections: Weld shop connections, unless otherwise shown.
Field Connections: Bolt field connections, except where welded connections, shear connectors, or other connections are indicated.

Holes for Other Work: Provide holes required for securing other work to structural steel framing. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.

High-strength threaded fasteners shall be provided for all Principal bolted connections and shall be installed in accordance with AISC Specifications.

Welded connections shall comply with AMS Code for procedures, appearance, and quality of welds and for methods used in connecting welded work.

CLEANING

Immediately prior to the painting process, surfaces which are scheduled to receive finish painting shall be cleaned to remove mill scale, rust, rust scale, and foreign matter using abrasives in accordance with SSPC.SP6-63 Commercial Blast Cleaning. Prior to blast cleaning, heavy deposits of oil and grease shall be removed in accordance with SSPC-SP1-63 Solvent Cleaning.

Immediately prior to the painting process, surfaces which are not scheduled to receive painting shall be cleaned by hand tool cleaning in accordance with SSPC-SP2-63 or by power tool cleaning in accordance with SSPC-SP3-63.

Paint application shall be in accordance with SSPC-PAI-64 Shop, Field, and Maintenance Painting.

Do not paint surfaces which are to be welded or high strength bolted with friction-type connections.

Do not paint surfaces which are scheduled to receive sprayed-on fireproofing.

ERECTION

Erection shall, in general, comply with the AISC Specifications and Code of Standard Practice

and as herein specified.

Erector shall examine the areas and conditions under which structural steel is to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Erector.

Temporary shoring and bracing shall be provided with connections of enough strength to bear imposed loads. Temporary guy lines shall be provided to achieve proper alignment of the structures as erection proceeds. Temporary planking and working platforms shall be provided as necessary to effectively complete the work.

Headed anchor bolts and other connections required for securing structural steel to foundations and other in-place work shall be furnished as necessary for presetting bolts and other anchors to accurate locations.

Furnish templates and other devices as necessary for setting bolts and other anchors to accurate locations.

Clean concrete bearing surfaces and roughen to improve bond. Clean the bottom surfaces of base plates. Set loose and attached base plates for structural members on wedges or other adjusting devices. Tighten anchor bolts after the supported members have been positioned and plumbed. Do not remove wedges or shims, but, if protruding, cut off flush with the edge of the base plate prior to packing with grout. Pack or float into form non-metallic non-shrink grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and cure according to the manufacturer's printed instructions.

Set structural members to the lines and elevations indicated. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment. Level and plumb individual members of the structure within specified AISC tolerances. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to field welds. Do not enlarge unfair holes in members by burning or using drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

Do not use gas cutting torches in the field for correcting fabrication errors in the structural framing. Cutting will be permitted only in secondary members which are not under stress, as acceptable to the Engineer. Finish gas-cut sections equal to a sheared appearance when permitted.

FIELD PAINTING

After the structural steel has been erected and before any superimposed construction in placed, apply one field coat of paint to all places where the shop coat of paint has rubbed

away, where the shop coat of paint was omitted because of field welding, or where field welding has damaged the shop coat of paint. Field coat of paint shall be the specified shop paint applied to result in a minimum dry film thickness of 2 mils. For all other paint applications, refer to Section 09900.

FIELD QUALITY CONTROL:

General: The Owner will employ an independent testing agency to conduct and interpret tests and state in reports whether the tested work complies with the requirements, and specifically state any deviations therefrom. The Contractor shall correct deficiencies in structural steel work which inspections and laboratory test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor's expense, as may be necessary to reconfirm any non-compliance of the original work, and as may be necessary to show compliance of corrected work.

FIELD-BOLTED CONNECTIONS:

Inspection: Inspect in accordance with AISC specifications including 100% visual inspection for presence of all bolts.

SHOP AND FIELD WELDING:

Perform radiographic tests, as required, of field-welded connections during erection of structural steel.

In addition to the above, additional testing may be performed by the Owner after the Engineer has completed his inspection.

PART 4- PAYMENT

All services shall be paid under the lump sum contract amount.

END OF SECTION 05101

SECTION 05500 - METAL FABRICATIONS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, Section 05101 apply to work of this Section.

SUMMARY

This section includes the following metal fabrications:

Miscellaneous steel trim.

Aluminum bar gratings and support systems.

Aluminum pipe railings.

Aluminum screens.

Steel brackets/supports.

Anchors for masonry work.

Access platforms.

Weir plates.

DEFINITIONS

Definitions in ASTM E 985 for railing-related terms apply to this section.

SYSTEM PERFORMANCE REQUIREMENTS

Structural Performance of Handrails and Railing Systems: Design, engineer, fabricate, and install handrails and railing systems to comply with requirements of ASTM E 985 for structural performance based on testing performed in accordance with ASTM E 894 and E 935.

Top Rail of Guardrail Systems: Capable of withstanding the following loads applied as indicated:

Uniform load of 50 lbf per linear ft. applied nonconcurrently, vertically downward or horizontally.

Concentrated and uniform loads above need not be assumed to act concurrently.

Handrails Not Serving as Top Rails: Capable of withstanding the following loads applied as indicated:

Concentrated load of 200 lbf applied at any point nonconcurrently, vertically downward or horizontally.

Uniform load of 50 lbf per linear foot applied nonconcurrently, vertically downward or horizontally.

Concentrated and uniform loads above need not be assumed to act concurrently.

Component Handrails: Component handrail systems will be acceptable.

Treads of Aluminum Stairs: Capable of withstanding a uniform load of 100 lbf per sq. ft. or a concentrated load of 300 lbf on an area of 4 sq. inches located in the center of the tread, whichever produces the greater stress.

Platforms of Aluminum Stairs: Capable of withstanding a uniform load of 100 lbf per sq. ft.

SUBMITTALS

General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

Product data for products used in miscellaneous metal fabrications, including paint products and grout.

Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other sections.

Where installed metal fabrications are indicated to comply with certain design loadings, include structural computations, material properties, and other information needed for structural analysis that has been signed and sealed by the qualified professional engineer who was responsible for their preparation.

Provide structural details for the following items:

1. Headworks
   - Handrail systems
   - Grating Systems
   - Pipe brackets
   - Access steps
   - Pipe Supports

- Platform extension between existing and new structure

2. Anoxic Tanks
   - Pipe brackets
   - Metal platform/walkway
   - Handrail systems

PROJECT CONDITIONS

Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

SEQUENCING AND SCHEDULING

Sequence and coordinate installation of wall handrails as follows:

Mount handrails only on completed walls. Do not support handrails temporarily by any means not satisfying structural performance requirements.

Mount handrails only on gypsum board assemblies reinforced to receive anchors, and where the location of concealed anchor plates has been clearly marked for benefit of Installer.

PART 2 - PRODUCTS

FERROUS METALS

Metal Surfaces, General: For metal fabrications exposed to view upon completion of the Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, rolled trade names, roughness, and, for steel sheet, variations in flatness exceeding those permitted by reference standards for stretcher-leveled sheet.

Steel Plates, Shapes, and Bars: ASTM A36.

Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.

Concrete Inserts: Threaded or wedge type; stainless steel. Provide bolts, washers, and shims as required.

ALUMINUM

Drawn Seamless Tube: ASTM B 483, 6063-T832.

Extruded Bars and Shapes: ASTM B 221, alloys as follows:

6063-T6 for bearing bars of gratings and shapes.

6061-T1 for grating cross bars.

Aluminum-Alloy Rolled Tread Plate: ASTM B 632, alloys as follows:

6061-T6 for platforms.

6061-T4 for treads.

Aluminum Sheet for Expanded Aluminum Grating: ASTM B 209, alloy 5052-H32.

Fasteners for Aluminum Gratings: Use fasteners made of same basic metal as fastened metal except use galvanized fasteners complying with ASTM A 153 for exterior aluminum units, unless otherwise indicated. Do not use metals that are corrosive or incompatible with metals joined.

FASTENERS

General: Provide stainless steel fasteners for exterior use or where built into exterior walls. Select fasteners for the type, grade, and class required.

PAINT

Shop Primer for Ferrous Metal: See Section 09900 of these Specifications.

Field Coat for Ferrous Metal: See Section 09900 of these Specifications.

FABRICATION, GENERAL

Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

Remove sharp or rough areas on exposed traffic surfaces.

Form exposed connections with hairline joints, flush and smooth, using concealed fasteners

wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.

Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware, screws, and similar items.

Fabricate joints that will be exposed to weather in a manner to exclude water or provide weep holes where water may accumulate.

MISCELLANEOUS FRAMING AND SUPPORTS

General: Provide framing and supports for applications indicated or which are not a part of structural framework, as required to complete work.

Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent other construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.

METAL BAR GRATINGS

General: Produce aluminum metal bar gratings of description indicated per NAAMM marking system that comply with the following:

Capable of withstanding a uniform load of 100 lbs per square foot or a concentrated load of 300 lbs on an area of 4 square inches, whichever produces the greater stress.

“Removable” sections where noted on the Drawings shall be limited to 24” width sections.

Metal Bar Grating Standard "Standard Specifications for Metal Bar Grating and Metal Bar Grating Treads" published in ANSI/NAAMM A202.1 "Metal Bar Grating Manual."

Fabricate pressure-locked (non-skid) “I”-bar aluminum gratings to comply with requirements indicated below:

Mark/Size: Swaged (pressure-locked with bearing bars one-inch o.c. and cross bars 2 inches o.c.)/I-shaped bearing bar sizes as indicated. Riveted, or welded type will not be acceptable.

Traffic Surface for Aluminum Bar Gratings: As follows: Grooved/non-skid.

Aluminum Finish: As follows: Mill.

Fabricate removable grating sections with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated, or if not indicated, as recommended by manufacturer, for attachment to supports.
Provide not less than 4 flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.

Furnish toe plates for attachment in field.

Toe plate height: 4 inches, unless a greater height indicated.

Fabricate cutouts in grating sections for penetrations indicated. Arrange layout of cutouts to permit grating removal without disturbing items penetrating gratings.

Edge band openings in grating that interrupt 4 or more bearing bars with bars of same size and material as bearing bars.

Do not notch bearing bars at supports to maintain elevation.

Acceptable Manufacturers: Subject to compliance with requirements, provide metal bar gratings by one of the following:

Alabama Metal Industries Corp.
Barnett/Bates Corp.
Blaw-Knox Grating Div., Blaw-Knox Corp.
IKG Industries
Klemp Corp.
Ohio Gratings, Inc.
Reliance Steel Products, Inc.
Trueweld, Inc.

ALUMINUM GUARDRAILS, HANDRAILS, AND RAILINGS:

All guardrails shall be furnished with a toeboard, except where concrete curbs are shown.

Handrail shall be the product of a company normally engaged in the manufacture of pipe railing. Railing shall be shop assembled in lengths not to exceed 24 feet for field erection.

Post spacing shall be a maximum of 6'-0". Posts and rails shall be a minimum of 1-1/2" Schedule 40 aluminum pipe, alloy 6063-T6 or 6105-T5, ASTM B-429 or B-221.

Handrail shall be made of pipe and fittings mechanically fastened together with stainless steel hardware.

Toeboard shall conform to OSHA Standards. Toeboard shall be a minimum of 4" high and shall attach to the post using clamps which will allow for expansion and contraction between posts. Toeboard shall be set 1/4" above the walking surface.

Wedge anchors shall be spaced 10d apart and 5d edge distance for no reduction in pullout strength. A safety factor of 4 shall be used on pullout values published by the manufacturer. Wedge anchors shall be Type 304 stainless steel.

Openings in the railing shall be guarded by a self-closing gate (OSHA 1910.23).

All handrail and components shall be clear anodized per Aluminum Association M10C22A41 (215-R1). The pipe shall be plastic wrapped to protect the finish.

All aluminum surfaces in contact with concrete, grout, or dissimilar metals will be protected with a coat of bituminous paint, mylar isolators, or other approved material.

ACCEPTABLE PRODUCTS/MANUFACTURERS:

A. Component aluminum handrail system shall be "TUFrail" by Thompson Fabricating - Birmingham, AL, "Interna-Rail" by Hollaender Corporation, Cincinnati, Ohio, or equal by Alumagard, Denver, Colorado.

PART 3 - EXECUTION

PREPARATION

Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

INSTALLATION - GENERAL:

Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.

Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

Provide temporary bracing or anchors in formwork for items that are to be built into concrete

masonry or similar construction.

Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint or zinc chromate primer.

INSTALLATION OF METAL BAR GRATINGS

General: Install gratings to comply with recommendations of NAAMM grating standard referenced under Part 2 that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

Secure removable units to supporting members with type and size of clips and fasteners indicated, or if not indicated as recommended by grating manufacturer for type of installation conditions shown.

Secure nonremovable units to supporting members by welding where both materials are the same; otherwise, fasten by bolting as indicated above.

INSTALLATION OF RAILINGS AND HANDRAILS

Adjust railings prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated, or if not indicated, as required by design loadings. Plumb posts in each direction. Anchor posts and railing ends in concrete with grout.

Field fabrication of the railing system is not permitted.

Set handrails plumb within 1/8" of vertical and align horizontally to within 1/8" in 12 feet.

Install wedge anchors to proper depth to develop full pullout and shear values. Check all fasteners and bolts in base connections and splices for tightness.

Adequate provisions for expansion and contraction shall be incorporated into the rail. Expansion joints shall be placed at 60-foot intervals and at all concrete expansion joints.

Toe boards shall be shipped loose and attached to the handrail in the field. Attachment to the posts will be made with clamps which will allow for expansion and contraction while maintaining a straight line.

All defective, damaged or otherwise improperly installed handrail shall be removed and replaced with material which complies with this section at no additional cost to the Owner.

Following installation, aluminum handrail shall be cleaned with a mild soap and clean water.

Acid solutions, steel wool, or harsh abrasives shall not be used.

PART 4- PAYMENT

Payment for all the metal fabrication services shall be covered under the lump sum contract amount.

END OF SECTION 05500

SECTION 07920 – JOINT SEALANTS

PART 1 GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY

This Section includes joint sealants for the following applications, including those specified by reference to this Section:

Exterior joints in the following vertical surfaces and horizontal non-traffic surfaces:

- Control and expansion joints in unit masonry.
- Joints between different materials listed above.
- Perimeter joints between materials listed above and frames of doors, windows, and louvers.
- Other joints as indicated.

Exterior joints in the following horizontal traffic surfaces:

- Isolation and contraction joints in cast-in-place concrete slabs.
- Tile control and expansion joints.
- Other joints as indicated.

Interior joints in the following vertical surfaces and horizontal non-traffic surfaces:

- Control and expansion joints on exposed interior surfaces of exterior walls.
- Perimeter joints of exterior openings where indicated.
- Tile control and expansion joints.
- Vertical joints on exposed surfaces of interior unit masonry walls and partitions.
- Perimeter joints between interior wall surfaces and frames of interior doors and windows
- Joints between plumbing fixtures and adjoining walls, floors, and counters.
- Other joints as indicated.

Interior joints in the following horizontal traffic surfaces:

- Isolation joints in cast-in-place concrete slabs.
- Control and expansion joints in tile flooring.
- Other joints as indicated.

Related Sections include the following:

Division 2 Section "Pavement Joint Sealants" for sealing joints in pavements, walkways, and curbing.

Division 4 Section "Unit Masonry Assemblies" for masonry control and expansion joint fillers and gaskets.

Division 8 Section "Glazing" for glazing sealants.

Division 9 Section "Gypsum Board Assemblies" for sealing perimeter joints of gypsum board partitions to reduce sound transmission.

Division 9 Section "Ceramic Tile" for sealing tile joints.

Division 9 Section "Acoustical Tile Ceilings" for sealing edge moldings at perimeters of acoustical ceilings.

Division 9 Section "Chemical-Resistant Brick Flooring" for sealing flooring joints.

PERFORMANCE REQUIREMENTS

Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

SUBMITTALS

Product Data: For each joint-sealant product indicated.

Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

QUALITY ASSURANCE

Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.

Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

PROJECT CONDITIONS

Do not proceed with installation of joint sealants under the following conditions:

When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.

When joint substrates are wet.

Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 PRODUCTS

MANUFACTURERS

Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

MATERIALS, GENERAL

Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

ELASTOMERIC JOINT SEALANTS

Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

Exterior Joints:

Sealant in contact with metal to be Dow Corning 795
Sealant on porous substrates to be Dow Corning 790, or equal

Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be no staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

Suitability for Contact with Food: Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

Single-Component Mildew-Resistant Neutral-Curing Silicone Sealant:

Products:

Pecora Corporation; 898.
Tremco; Tremsil 600 White, or equal

Type and Grade: S (single component) and NS (non-sag).

Class: 25.

Use Related to Exposure: NT (non-traffic).

Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

Use O Joint Substrates: color anodic aluminum, aluminum coated with a high-performance coating, galvanized steel, ceramic tile and other Use O substrates.

PREFORMED JOINT SEALANTS

Preformed Silicone-Sealant System: Manufacturer's standard system consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.

Products:

Dow Corning Corporation; 123 Silicone Seal.
Pecora Corporation; Sil-Span, or equal

JOINT-SEALANT BACKING

General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.

Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

MISCELLANEOUS MATERIALS

Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way and formulated to promote optimum adhesion of sealants to joint substrates.

Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

EXAMINATION

Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

Proceed with installation only after unsatisfactory conditions have been corrected.

PREPARATION

Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

Concrete.
Masonry.
Unglazed surfaces of ceramic tile.

Remove laitance and form-release agents from concrete.

Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

Metal.
Glass.
Porcelain enamel.
Glazed surfaces of ceramic tile.

Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

INSTALLATION OF JOINT SEALANTS

General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

Do not leave gaps between ends of sealant backings.

Do not stretch, twist, puncture, or tear sealant backings.

Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

Install sealants using proven techniques that comply with the following and at the same time backings are installed:

Place sealants so they directly contact and fully wet joint substrates.

Completely fill recesses in each joint configuration.

Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

Installation of Preformed Silicone-Sealant System: Comply with the following requirements:

Apply masking tape to each side of joint, outside of area to be covered by sealant system.

Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch. Hold edge of sealant bead 1/4 inch inside masking tape.

Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.

Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.

CLEANING

Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

PROTECTION

Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or

deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

PART 4- PAYMENT

Payment for all these services shall be included under the lump sum contract amount.

END OF SECTION 07920

SECTION 09900 - PAINTING

PART 1 - GENERAL

WORK INCLUDED:

This specification covers preparation of surfaces, performance and completion of painting of all surfaces as required by the drawings and as specified herein.

SYSTEM DESCRIPTION:

Performance Requirements: Include the following performance data as certified by a qualified testing laboratory:

1. Abrasion - ASTM D 4060, CS-17 Wheel, 1,000 grams load.
2. Adhesion - ASTM D 3359 Method B.
3. Exterior Exposure - Exposed at 45 degrees facing ocean (Atlantic Sea Coast)
4. Hardness - ASTM D 3363-74
5. Humidity - ASTM D 2247-68
6. Salt Spray (FOG) - ASTM B 117-73

QUALITY ASSURANCE:

All materials specified herein meet the current regulations in effect for the emission of Volatile Organic Compounds (V.O.C.) for the State and Federal Governments.

Coating materials specified in contact with Potable Water must be approved in writing by both the State of Tennessee, Department of Environment and Conservation and by the current Federal regulatory authority in effect at the time of application.

DELIVERY, STORAGE AND HANDLING:

All materials shall be delivered to jobsite in original sealed and labeled containers of the paint manufacturer.

PROJECT/SITE CONDITIONS:

Coatings shall be applied during good painting weather. Air and surface temperatures shall be within limits prescribed by the manufacturer for the coating being applied and work areas shall be reasonably free of airborne dust at the time of application and while coating is drying.

PART 2 - PRODUCTS

MATERIAL QUALITY:

Provide best quality grade of various types of coatings are regularly manufactured by acceptable paint materials manufacturers. Materials not displaying manufacturer's identification as a standard, best-grade product will not be acceptable.

Federal specifications establish minimum acceptable quality for paint materials. Provide written certification from paint manufacturer that materials provided meet or exceed these minimums.

Manufacturer's products which comply with coating quantitative requirements of applicable Federal Specifications, yet differ in quantitative requirements, may be considered for use when acceptable to Designer. Furnish material data and manufacturer's certificate of performance to Designer for any proposed substitutions.

Provide undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer and use only within recommended limits.

MATERIALS:

Where brand names are used in this section, they are used as a general descriptive reference only. Use of other brands of equal quality and performance will be permitted.

PIPING COLOR CODE:

To facilitate identification of piping in plants and pumping stations, the following color scheme will be utilized:

Water Lines

Raw	Olive Green
Settled or Clarified	Aqua
Finished or Potable	Dark Blue

GENERAL DESIGN CONSIDERATIONS:

Chemical Lines

Alum or Primary Coagulant	Orange
Ammonia	White
Carbon Slurry	Black
Caustic	Yellow with Green Band
Chlorine (Gas and Solution)	Yellow
Fluoride	Light Blue with Red Band
Lime Slurry	Light Green
Ozone	Yellow with Orange Band
Phosphate Compounds	Light Green with Red Band
Polymers or Coagulant Aids	Orange with Green Band
Potassium Permanganate	Violet
Soda Ash	Light Green with Orange Band
Sulfuric Acid	Yellow with Red Band
Sulfur Dioxide	Light Green with Yellow Band

Waste Lines

Backwash Waste	Light Brown
Sludge	Dark Brown
Sewer (Sanitary or Other)	Dark Gray
Recycle Water	Light Gray with “Non-Potable” Labeling

Other

Compressed Air	Dark Green
Gas	Red
Other Lines	Light Gray

In situations where two colors do not have enough contrast to easily differentiate between them, a six-inch band of contrasting color should be on one of the pipes at approximately 30-inch intervals. The name of the liquid or gas arrows indicating the direction of flow should also be on the pipe.

Colors, where not specified, shall be as selected by the Engineer.

PART 3 - EXECUTION

EXAMINATION:

Examine surfaces prior to surface preparation and determine if they are suitable to proceed in accordance with paint manufacturers recommendations. Commencement of application implies acceptance of substrate and responsibility thereof.

SURFACE PREPARATION:

General:

Prepare surfaces in accordance with coating system's specifications. Touch up welds, burned and abraded areas with specified primer before applying field coats.

Allow each coat to dry thoroughly before applying next coat.

Finish coats shall be uniform in color and sheen without streaks, laps, runs, sags or missed areas. Primer and finish coats shall be furnished from the same manufacturer to ensure compatibility.

All surface preparation and repairs shall be approved by the Designer/Owner before primer is applied.

Correct work that is not acceptable and request re-inspection.

Steel, Non-Immersion Service - Structural,
Tanks, Pipes, and Equipment:

To be prepared in accordance with Steel Structures Painting Council recommendations for an SSPC-SP6 Commercial Blast Cleaning.

Steel, Immersion Service - Structural, Tanks,
Pipes and Equipment, and Mill Coated Steel Pipe:

To be prepared in accordance with Steel Structures Painting Council recommendations for an SSPC-SP10 Near-White Blast Cleaning.

Metal Anchorage for Buried Piping:

To be prepared in accordance with Steel Structures Painting Council recommendations for an SSPC-SP3 Power Tool Clean.

Factory Primed Steel and Mill
Coated Steel Pipe (Non-Immersion):

Surface shall be clean and dry.

Concrete, Dense Masonry and Porous Masonry:

Exterior, Non-Immersion -Surface shall be clean and dry. New concrete will be cured a minimum of 28 days.

Immersion - Brush-Off Blast. New concrete will be cured minimum of 28 days.

Plaster, Wallboard, Wood and Insulated Pipe:

Interior/Exterior - Surface shall be clean and dry.

APPLICATION:

Materials shall be mixed, thinned and applied according to the manufacturer's printed instructions and in accordance with AWWA D 102-78.

CLEANUP:

Remove and dispose of all rubbish or other unsightly material, in a legal manner, leaving the premises in a clean condition.

PROTECTION:

Request acceptance of each coat before applying succeeding coats.

Correct work that is not acceptable and request re-inspection.

PAINTING SCHEDULE:

Steel - Structural, Tanks, Pipes and Equipment:

1. Exterior, Non-Immersion

   1st Coat: Apply Tnemec Series 66-1255 Hi-Build Epoxoline at 4.0-6.0 mils DFT, or equal.

2nd Coat: Apply Tnemec Series 73-Color Endura-Shield III at 3.0-5.0 mils DFT, or equal.

2. Immersion, Potable or Non-Potable Water

1st Coat: Apply Tnemec Series 66-1255 Hi-Build Epoxoline (*) at 3.0-5.0 mils DFT, or equal.

2nd Coat: Apply Tnemec Series 66-Color Hi-Build Epoxoline (*) at 4.0-6.0 mils DFT, or equal.

* Use Tnemec Series 20 Pota-Pox in Potable Water, or equal.

3. Immersion, Non-Potable water with high levels of Hydrogen Sulfide

1st Coat: Apply Tnemec Series 120-5002 Vinester at 12.0-18.0 mils DFT, or equal.

2nd Coat: Apply Tnemec Series 120-5001 Vinester at 12.0-18.0 mils DFT, or equal.

4. Interior, Non-Immersion

1st Coat: Apply Tnemec Series 66-1255 Hi-Build Epoxoline at 3.0-5.0 mils DFT, or equal.

2nd Coat: Apply Tnemec Series 66-Color Hi-Build Epoxoline at 4.0-6.0 mils DFT, or equal.

5. Metal Anchorage for Buried Piping

1st Coat: Apply Tnemec Series 46-450 Heavy TnemeCol at 13.0-16.0 mils DFT, or equal.

6. Miscellaneous Castings, Including Manhole Rings and Covers

One Coat: Apply Tnemec Series 46H-413 Hi-Build Tneme-Tar at 12.0-16.0 mils DFT, or equal.

7. Factory Primed

Intermediate Coat: Apply Tnemec Series 50-330 Poly-Ura-Prime at 2.0-3.0 mils DFT, or equal.

Finish Coat: See topcoat for exposure. System 3.06 A. 1, 2, 4, or 6.

Mill Coated Steel Pipe:

1. Exterior of Pipe, Non-Immersion

   1st Coat: Apply Tnemec Series 66-1255 Hi-Build Epoxoline at 4.0-6.0 mils DFT, or equal.

   2nd Coat: Apply Tnemec Series 73-Color Endura-Shield III at 3.0-5.0 mils DFT, or equal.

2. Immersion, Potable or Non-Potable Water

   1st Coat: Apply Tnemec Series 66-1255 Hi-Build Epoxoline (*) at 3.0-5.0 mils DFT, or equal.

   2nd Coat: Apply Tnemec Series 66-Color Hi-Build Epoxoline (*) at 4.0-6.0 mils DFT, or equal.

   * Use Tnemec Series 20 Pota-Pox in Potable Water, or equal.

Concrete: Provide clear sealant at all concrete surfaces. Refer to Divisions 3 and 7 of the Technical Specifications for additional information and/or requirements.

Porous Masonry:

1. Interior

   Primer: Apply Sherwin-Williams Pro Mar 200 Latex Wall Primer, 1.1 mils DFT, or equal.

   Finish: Apply two (2) coats of Sherwin-Williams Pro Mar 200 Alkyd Semi-Gloss Enamel, 17 mils DFT, or equal.

Plaster and Wallboard:

1. Interior

   Primer: Apply Sherwin-Williams Pro Mar 200 Latex Wall Primer, 1.1 mils DFT, or equal.

   Finish: Apply two (2) coats of Sherwin-Williams Pro Mar 200 Alkyd Semi-Gloss Enamel, 17 mils DFT, or equal.

Wood:

1. Interior

Primer: Apply Sherwin-Williams Pro Mar 200 Latex Wall Primer, 1.1 mils DFT, or equal.

Finish: Apply two (2) coats of Sherwin-Williams Pro Mar 200 Alkyd Semi-Gloss Enamel, 17 mils DFT, or equal.

2. Exterior

Primer: Apply Sherwin-Williams A-100 Exterior Wood Primer, Y24W20, 2.2 mils DFT, or equal.

Finish: Apply two (2) coats of Sherwin-Williams Pro Mar Alkyd Flat House Paint, 1.8 mils DFT, or equal.

Insulated Pipe:

1. Interior

1st Coat: Apply Tnemec Series 6/7-Color Tneme-Cryl at 2.0-3.0 mils DFT, or equal.

2nd Coat: Apply Tnemec Series 6/7-Color Tneme-Cryl at 2.0-3.0 mils DFT, or equal.

Non-Ferrous Metals:

1. Interior

One Coat: Apply Tnemec Series 66-Color Hi-Build Epoxoline at 4.0-6.0 mils DFT, or equal.

2. Exterior

1st Coat: Apply Tnemec Series 66-Color Hi-Build Epoxoline at 4.0-6.0 mils DFT, or equal.

2nd Coat: Apply Tnemec Series 73-Color Endura-Shield III at 3.0-5.0 mils DFT, or equal.

Pavement Markings:

1. Two coats of paint, white.

PART 4- PAYMENT

Payment for all painting services shall be included under the lump sum contract amount.

END OF SECTION 09900

SECTION 10380 - TEMPORARY BYPASS PUMPING SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. Under this item the Contractor is required to furnish all materials, labor, equipment, power, maintenance, etc. to implement a temporary pumping system for the purpose of diverting the existing flow around the work area for the duration of the work, unless an otherwise approved construction plan is reviewed and approved by the Engineer/Owner.

   Work areas may include:

   - Secondary Clarifiers
   - Plant Drainage Pump Station
   - Yard piping infrastructure

B. The bypass pumping systems shall be suitable for maintaining plant process flows and supplemental support systems as approved by the Owner and Engineer.

C. The design, installation and operation of the temporary pumping system shall be the Contractor's responsibility. The Contractor shall employ the services of a vendor who can demonstrate to the engineer that he specializes in the design and operation of temporary bypass pumping systems. The vendor shall provide at least five (5) references of projects of a similar size and complexity as this project performed by his firm within the past three years. The bypass system shall meet the requirements of all local, state, and federal codes.

1.02 REQUIREMENTS FOR SUBMITTING BIDS

A. The Contractor shall prepare with the vendor a specific, detailed description of the proposed pumping system and submit it and the vendor's references.

B. The Contractor shall submit to the Engineer detailed plans and descriptions outlining all provisions and precautions to be taken by the Contractor regarding the handling of existing wastewater flows. This plan must be specific and complete, including such items as schedules, locations, elevations, capacities of equipment, materials and all other incidental items necessary and/or required to insure proper protection of the facilities, including protection of the access and bypass pumping locations from damage due to the discharge flows, and compliance with the requirements and permit conditions specified in these Contract Documents. No construction shall begin until all provisions and requirements have been reviewed by the Engineer.

C. The plan shall include but not be limited to details of the following:

1) Staging areas for pumps;
2) Sewer plugging method and types of plugs;
3) Number, size, material, location and method of installation of suction piping;
4) Number, size, material, method of installation and location of installation of discharge piping;
5) Bypass pump sizes, capacity, number of each size to be on site and power requirements;
6) Calculations of static lift, friction losses, and flow velocity (pump curves showing pump operating range shall be submitted);
7) Standby power generator size, location;
8) Downstream discharge plan;
9) Method of protecting discharge manholes or structures from erosion and damage;
10) Thrust and restraint block sizes and locations;
11) Sections showing suction and discharge pipe depth, embedment, select fill and special backfill;
12) Method of noise control for each pump and/or generator;
13) Any temporary pipe supports, and anchoring required;
14) Design plans and computation for access to bypass pumping locations indicated on the drawings;
15) Calculations for selection of bypass pumping pipe size;
16) Schedule for installation of and maintenance of bypass pumping lines;
17) Plan indicating selection location of bypass pumping line locations.

1.03 EQUIPMENT

A. All pumps used shall be fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps in the priming system. The pumps may be electric, or diesel powered. All pumps used must be constructed to allow dry running for long periods of time to accommodate the cyclical nature of effluent flows.

B. The Contractor shall provide the necessary stop/start controls for each pump.

C. The Contractor shall include one stand-by pump of each size to be maintained on site. Back-up pumps shall be on-line, isolated from the primary system by a valve.

D. Discharge Piping -In order to prevent the accidental spillage of flows all discharge systems shall be temporarily constructed of rigid pipe with positive, restrained joints.

E. Under no circumstances will aluminum "irrigation" type piping or glued PVC pipe be allowed. Discharge hose will only be allowed in short sections and by specific permission from the engineer.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

Bypass pumping systems shall have enough capacity to pump a peak flow of 1400 gpm. The Contractor shall provide all pipeline plugs, pumps of adequate size to handle peak flow, and temporary discharge piping to ensure that the total flow of the main can be safely diverted around the section to be repaired. Bypass pumping system will be required to be operated 24 hours per day.

The Contractor shall have adequate standby equipment available and ready for immediate operation and use in the event of an emergency or breakdown. One standby pump for each size pump utilized shall be installed at the mainline flow bypassing locations, ready for use in the event of primary pump failure.

Bypass pumping system shall be capable of bypassing the flow around the work area and of releasing any amount of flow up to full available flow into the work area as necessary for satisfactory performances of work.

The Contractor shall make all arrangements for bypass pumping during the time when the main is shut down for any reason. System must overcome any existing force main pressure on discharge.

B. Performance Requirements:

It is essential to the operation of the existing sewerage system that there be no interruption in the flow of sewage throughout the duration of the project. To this end, the Contractor shall provide, maintain and operate all temporary facilities such as dams, plugs, pumping equipment (both primary and back-up units as required), conduits, all necessary power, and all other labor and equipment necessary to intercept the sewage flow before it reaches the point where it would interfere with his work, carry it past his work and return it to the existing sewer downstream of his work.

The design, installation and operation of the temporary pumping system shall be the Contractor's responsibility. The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.

The Contractor shall provide all necessary means to safely convey the sewage past the work area. The Contractor will not be permitted to stop or impede the main flows under any circumstances.

The Contractor shall maintain sewer flow around the work area in a manner that will not cause surcharging of sewers, damage to sewers and that will protect public and private property from damage and flooding.

The Contractor shall protect water resources, wetlands and other natural resources.

1.05 FIELD QUALITY CONTROL AND MAINTENANCE

A. Test:

The Contractor shall perform leakage and pressure tests of the bypass pumping discharge piping using clean water prior to actual operation. The engineer will be given 24 hours notice prior to testing.

B. Inspection:

Contractor shall inspect bypass pumping system every two hours to ensure that the system is working correctly.

C. Maintenance Service:

The Contractor shall insure that the temporary pumping system is properly maintained, and a responsible operator shall always be on hand when pumps are operating.

D. Extra Materials:

Spare parts for pumps and piping shall be kept on site as required.

Adequate hoisting equipment for each pump and accessories shall be maintained on the site.

1.06 PREPARATION:

A. Precautions

Contractor is responsible for locating any existing utilities in the area the Contractor selects to locate the bypass pipelines. The Contractor shall locate his bypass pipelines to minimize any disturbance to existing utilities and shall obtain approval of the pipeline locations from the City and the Engineer. All costs associated with relocating utilities and obtaining all approvals shall be paid by the Contractor.

During all bypass pumping operation, the Contractor shall protect the Pumping Station and main and all local sewer lines from damage inflicted by any equipment. The Contractor shall be responsible for all physical damage to the

Pumping Station and main and all local sewer lines caused by human or mechanical failure.

1.07 INSTALLATION AND REMOVAL

A. The Contractor shall remove manhole sections or make connections to the existing sewer and construct temporary bypass pumping structures only as approved by the Engineer and as may be required to provide adequate suction conduit.

B. Plugging or blocking of sewage flows shall incorporate a primary and secondary plugging device. When testing and approval of work is completed and accepted by the Engineer, plugging or blocking is no longer needed for performance and acceptance of work, it is to be removed in a manner that permits the sewage flow to slowly return to normal without surge, to prevent surcharging or causing other major disturbances downstream.

C. When working inside manhole or force main, the Contractor shall exercise caution and comply with OSHA requirements when working in the presence of sewer gases, combustible or oxygen-deficient atmospheres, and confined spaces.

D. The installation of the bypass pipelines is prohibited in all saltmarsh/wetland areas. The pipeline must be located off streets and sidewalks and on shoulders of the roads. When the bypass pipeline crosses local streets and private driveways, the contractor must place the bypass pipelines in trenches and cover with temporary pavement. Upon completion of the bypass pumping operations, and after the receipt of written permission from the Engineer, the Contractor shall remove all the piping, restore all property to pre-construction condition and restore all pavement. The Contractor is responsible for obtaining any approvals for placement of the temporary pipeline within public ways from the City.

PART 4- PAYMENT

Payment for any and all bypass pumping services shall be covered under the lump sum contract amount.

END OF SECTION 10380

SECTION 11000 - BASIC EQUIPMENT REQUIREMENTS

PART 1- GENERAL

All equipment included in these Specifications or as shown on the Drawings, shall be furnished completely, installed and operational. All materials and accessories needed to be operational, whether specifically mentioned or not, shall be furnished.

The Contractor shall furnish aluminum angles (3" x 3" x 1/4") mounted to structure using anchors as specified in Division 3 with stainless steel hardware for all equipment control panels, other equipment panels, disconnects, etc. as needed for equipment.

All metal surfaces in contact with or adjacent to water/wastewater shall be coated with paint as described under Section 09900.

All existing equipment that is to be relocated or incorporated into a new system due to the nature of this work is to be calibrated and adjusted based on the manufacturer's recommendations at the expense of the Contractor. This includes but not limited to: flow meters, etc.

Location of all control panels, instrumentation displays, field instruments and their accessories shall be field verified with Engineer/Owner for approval prior to installation. Any relocation required from uncoordinated or unauthorized installation of these items will be at the expense of the Contractor.

Where noted on the Drawings or the Technical Specifications, heat trace systems shall be temperature control systems (dual circuits) such as Thermon Model TCM2 with BSX heating cable, or equal. Each unit shall be enclosed in a NEMA 4X FRP enclosure, furnished with heat sink, standard alarm output with trip lights, dual Terminator DL kits with end of circuit indication, and an RTD-AMB temperature sensor and housing. Dedicated power circuits shall be provided by the Contractor to each heat trace system.

Each heat trace tape system shall be designed based on the length and size of pipe to be covered, insulation thickness, and heat transfer to maintain a system temperature of 40 degrees F when the ambient temperature is 10 degrees F.

PART 2- MEASUREMENT AND PAYMENT:

No separate measurement and payment will be made for this work. It will be considered a subsidiary obligation of the Contractor under the lump sum price bid for project.

END OF SECTION 11000

SECTION 11210 CENTER FEED CLARIFIER

PART 1 - GENERAL

1.01 DESCRIPTION

A. There shall be furnished one (1) clarifier mechanism, each suitable for installation in a concrete basin as shown on the contract drawings.

B. Each mechanism shall be a bridge supported center feed unit with peripheral effluent collection. A center drive mechanism shall be provided for rotation of the two rake arms with rake blades & stainless steel squeegees.

C. The equipment shall be designed to effectively settle mixed liquor suspended solids and scrape the settled solids from the basin floor to the sludge collection pit as shown on the drawings. The clarified effluent shall be collected uniformly by the peripheral launder. Surface scum shall be collected by the scum skimming arm and discharged through the scum trough and exit through the withdrawal pipe.

D. The equipment furnished for each clarifier mechanism shall include but not be limited to: grated walkway with handrails, center drive assembly, center drive platform, full diameter bridge, influent feedwell, influent piping, energy dissipating inlet (EDI), center drive shaft, sludge collection arms with spiral rake blades, rotating sludge pit scraper, surface scum skimming equipment, scum collection trough, effluent weir plates and scum baffle, offset inboard effluent launders, anchor bolts and assembly fasteners.

E. Except where specifically indicated otherwise, all plates and structural members designated for submerged service shall have a minimum thickness of 1/4 inch. All structural steel will conform to ASTM A992-50 requirements and steel plate will conform to ASTM requirements. All anchor bolts used to secure the mechanism to the tank shall be hot dipped galvanized high strength steel. All structural fasteners shall be of Galvanized A325 steel. Handrail, skimmer, and rake blade squeegee fasteners shall be 18-8 stainless steel.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A.	CONCRETE	Division 3
B.	STEEL MATERIAL	Division 5
C.	FINISHES	Division 9
D.	CONTROLS	Division 13
E.	MOTORS	Division 16

1.03 PROCESS REQUIREMENTS

A.	Design average flow	0.472 MGD (327gpm)
G.	Drive continuous torque	6,000 ft-lb
I.	Drive momentary peak torque	12,000 ft-lb
J.	Mechanism rotation	Clockwise
K.	Rake arm tip speed,	10 ft/min

1.04 DESIGN REQUIREMENTS (Dimensions noted below are approximate and are to be field verified by Supplier//Contractor)

A.	Basin diameter	48'-0"
B.	Side water depth	12'-0"
C.	Tank freeboard	1'-6"
D.	Floor slope	0.2:12
E.	Driveshaft diameter	6"
F.	Feedwell diameter	10’-0”
G.	Feedwell submerged depth	4'-6"
H.	Inlet Pipe diameter	12”
I.	Skimmer Arm Length	full clarification radius
J.	Scum box width	3'-0"
K.	Length of Weir Plates	139 linear feet

1.05 FIELD SERVICE REQUIREMENTS

A. Clarifier Manufacturer to provide optional daily rate for on-site service for start-up & commissioning.

1.06 REFERENCES

A. American Society of Testing Materials (ASTM):
   1. A-36 Structural Steel Specifications
   2. 304 Bolt Specifications
   3. A-123 Hot-Dip Galvanized Coatings
   4. A-153 Hot-Dip Galvanized Bolts
   5. A-48 Cast Iron Specifications
   6. A-536 Ductile Iron Specifications
   7. A-283C Steel Plate Specifications

B. American Iron and Steel Institute (AISI), Heat Treated Steel Specifications
C. American Gear Manufacturers' Association (AGMA), Gear Ratings
D. American Welding Society (AWS), Current Standards
E. Anti-friction Bearing Manufacturers' Association (AFBMA), Bearing Life Specifications

F. National Electrical Manufacturer's Association (NEMA), Motor Design Standards
and Standards for Control Enclosures

1.07 QUALITY ASSURANCE

A. The clarifier equipment manufacturer shall modify their standard equipment to meet the minimum values specified for dimensions, design, and the intent of this specification.

B. Manufacturers regularly engaged in the manufacture of the clarifier equipment as specified herein and who can demonstrate equipment of this specified design, in actual service for a period of not less than 5 years will be considered as acceptable manufacturers. Manufacturer must have local service representative within the state of Tennessee.

C. Manufacturers shall show evidence of quality assurance in manufacturing and supplying equipment essential in details to the equipment herein specified.

D. Manufacturers to have local representation with a qualified Professional Engineer, licensed in the state of Tennessee, on staff available for technical support. Representative to have a local service shop located no further than 350 miles from project location. Representative should have the capability to repair and refurbish all equipment on-site at each Plant described herein. This includes providing all necessary expertise, equipment, and labor to do so.

E. Manufacturers not named in the specification and meeting the requirements as set forth in in this Section 1.07 must submit to the Engineer detailed information describing how their proposed equipment will meet the specification. The detailed information shall include, but not be limited to calculations, dimensional data, materials of construction and an installation list with address, telephone number, and an individual's name directly employed by the owner of the equipment. Additionally must be able to provide details satisfy Section 1.07.D.

1.08 CONTRACTOR'S SUBMITTALS

A. The contractor shall submit complete shop drawings of all equipment furnished for this project as covered by these specifications. The contractor's submittal must include a certification that the submitted material describes exactly the equipment to be provided. Substitutions of equipment subsequent to submittal approval will not be accepted.

B. The clarifier equipment manufacturer shall furnish as a minimum the following design and description information to establish compliance with these specifications:

1. Certified general arrangement and tank dimensional drawings.
2. Certificate stating that the equipment to be provided for this project meets or exceeds all structural requirements of these specifications. The certificate shall state the respective loads and design criteria.
3. Drive mechanism rating calculations, verifying the compliance of the drive gears and bearings with the specified continuous torque rating and bearing life rating.
4. Calculations to demonstrate that the scraper design has adequate capacity to transport the maximum day sludge loadings per Section 1.03.
5. Motor data and catalog information. Electrical drawings as applicable to the supply of the clarifier equipment manufacturer.
6. Catalog cut sheets for purchased sub-components.

1.09 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals will be provided by the clarifier manufacturer at least two weeks prior to shipment of all major equipment components. Each manual shall be a bound, indexed binder with drawings and parts lists.

B. As a minimum the manual shall contain:

1. Certified as-built drawings (general arrangement and general arrangement detail drawings).
2. Erection drawings.
3. A complete bill of materials for the equipment including the weights of all structural steel components.
4. Installation and maintenance instructions for the specific equipment including the erection sequence, maintenance and trouble-shooting check points, and complete lubrication procedures with recommended grades of lubricants.
5. Cut sheets for all equipment items purchased from sub-vendors.
6. A list of the clarifier manufacturer's recommended spare parts specifically denoting wear items, long delivery items, and all items convenient for stocking as optional replacement items.

1.10 DELIVERY

A. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations, properly match-marked for ease of field erection.

B. All components shall be erected immediately upon receipt from the clarifier manufacturer or stored in strict conformance with storage recommendations provided by the clarifier manufacturer in the operations and maintenance manual.

C. The mechanism shall be lubricated in strict accordance with the instructions of the clarifier manufacturer's field service representative. The required lubricants shall be provided by the contractor.

PART 2 - PRODUCTS

2.01 GENERAL

A. The clarifier mechanism shall be of the bridge-mounted drive type, supported by a full span structural steel beam bridge, with the flow entering the tank through the sidewall. Flow will pass through an EDI cap on the influent pipe before entering the influent feed well, where flow will be dispersed evenly throughout the tank. The clarifier shall be designed to remove settled sludge uniformly through a sludge collection cone in the bottom of the tank.

2.02 WALKWAY ACCESS BRIDGE

A. The clarifier shall be provided with a 36 inch clear open width walkway extending from the tank wall to the center drive platform. The walkway shall be supported at the center by the drive unit and supported on the opposite end by the tank wall. As a minimum the walkway shall be designed to safely withstand all dead loads plus a live load of 40 pounds per square foot with a maximum deflection of l/360, over the entire span. The walkway shall consist of beams or a structural steel truss, with either sufficiently braced to resist the specified design loads. The walkway decking shall be aluminum grating.

B. A center drive operations platform shall be provided. It shall be adequately sized to provide clearance around the center assembly and drive controls for maintenance and service. The drive platform shall be decked with aluminum grating and have sufficient structural steel supports to meet the specified design load conditions.

C. Provide handrails with toe kick-plate along both sides of the walkway and around the center drive platform. The handrailing shall be in conformance with the handrail specifications, found within this set of bid documents, and shall be as shown on the drawings.

2.03 RAKE ARMS AND DRIVESHAFT

A. The center driveshaft shall be of steel pipe construction, with connections for the two (2) sludge rake arms, and feedwell supports. The top end of the driveshaft shall be bolted to the drive mounting flange which shall rotate the shaft with the attached arms and feedwell. The minimum pipe size used for the driveshaft shall be 6" schedule 80.

B. The clarifier mechanism shall include two (2) sludge removal arms, with steel rake blades and adjustable 14-gauge 304 stainless steel squeegees. The rake blades shall provide complete raking of the basin floor twice per revolution.

C. The rake blades shall consist of a minimum 3/16 inch thick steel plate. Each rake truss support arm shall be provided with the necessary outrigger bracing and other blade support structures, to ensure that the complete blade can be properly located and adjusted in the field.

D. The rake blades shall terminate in the center to within 1 inch of the center sludge removal pit.

2.04 INFLUENT FEEDWELL

A. The influent feedwell shall be supported by structural members attached to the rotating drive shaft. The feedwell shall be fabricated out of 3/16 inch steel plate with upper and lower reinforcing rim angles and stiffeners as required. Properly sized scum ports shall be equally spaced around the feedwell periphery to allow scum to exit from the feedwell at water level.

2.05 SURFACE SCUM SKIMMING EQUIPMENT

A. Each clarifier shall be equipped with two full radius skimmer arm assemblies to collect and discharge surface scum into a 3'-0" wide scum trough cantilevered from the tank wall.

B. Each skimmer arm shall be either a structural steel truss assembly, fabricated tube assembly, or bent plate assembly cantilevered from the rotating feedwell. Tie rods shall be properly located to allow adjustment of the skimmer arm as well as to resist horizontal forces.

C. Each skimmer arm shall be equipped with a hinged 1/2 inch 60 durometer neoprene wiper blade extending width of the scum trough. The neoprene blade shall be fastened to the arm with stainless steel fasteners with steel back-up bars.

D. The scum trough shall be fabricated from 1/4 inch steel plate and shall be supported from the tank wall as shown on the drawings. The trough and

support structure shall be designed for all dead loads plus a 200 hundred pound point load at the feedwell end of the trough with no more than 1/2 inch deflection. The approach ramp of the trough shall be of radial design, having a tapered width and a variable slope that will enable the full length of the skimmer wiper to make simultaneous and continuous contact with the entire ramp along a radial line, at each revolution of the skimmer arm. A 6-inch schedule 40 pipe connection shall be provided at for connection to the scum drain line.

E. The clarifier equipment manufacturer shall furnish a flush valve assembly for automatic flushing of the scum trough and scum pipe. The flush valve assembly shall be adjustable to allow 0 to 20 gallons of clarified effluent to enter the scum trough as the skimmer assembly passes over the scum box

2.06 EFFLUENT WEIR AND SCUM BAFFLE

A. Effluent weir plates shall consist of 9 inch deep x 1/4 inch thick FRP sections to be vertically adjustable. To prevent leakage all surfaces between the launder walls and weir plates shall be given a seal coat of suitable mastic by the erection contractor.

B. The scum baffle plates shall consist of 12 inch deep x 1/4 inch thick FRP sections supported from the tank wall by FRP angle brackets.

2.07 SURFACE PREPARATION AND PAINTING

A. All non-submerged steel shall be sandblasted to SSPC-SP-6 specifications and given one coat of manufacturer's high build epoxy primer minimum 2-3 MDFT & one coat of manufacturer’s polyurethane enamel. All submerged steel shall be sandblasted to SSPC-SP-10 specifications and given two coats of manufacturer's high solids epoxy minimum of 2-3 MDFT.

B. Gear motors shall be furnished with manufacturer's standard enamel.

2.08 CLARIFIER DRIVE UNIT

A. The drive mechanism shall consist of an electric motor, a primary reduction unit, and a final reduction unit. All components are directly coupled, eliminating chains and V-belts. The drive unit output torque shall be limited by a torque overload protection device.

B. The primary reduction unit shall be mounted on top of the final gear reducer with direct shaft coupling.

1. The primary reduction unit shall use helical gearing and be permanently grease lubricated.

2. The primary reduction unit shall transmit torque to the input shaft of the intermediate gear reducer through a shear pin.
3. The L_{10} life of the primary gearbox bearings shall be in excess of 100,000 hours at continuous torque rating of the drive unit.

C. Final reduction unit:
1. The final reduction unit shall be a planetary gearbox.
2. The final reduction unit shall be permanently lubricated.

D. Electric motor:
1. The drive motor shall be Mill and Chemical duty, TEFC, 1.15 Service Factor, Class F insulation, or approved equal.

E. Torque indication and overload protection:
1. The torque monitoring and protection device shall be positioned between the primary helical gearbox and secondary planetary gearbox to monitor reaction torque between these two gearboxes.
2. The digital meter is calibrated in ft.lbs to indicator final output torque of the drive unit.
3. The digital meter shall be equipped with two switches and a 4-20 ma signal. The switches can independently energize an alarm circuit and motor cutoff circuit when the load of the mechanism reaches the customer specified torque settings.
4. In addition to alarm and cutoff switches, and 4-20 ma signal, the drive unit is also protected by a brass shear pin.

F. Corrosion prevention:
1. All fabricated steel parts will be abrasive blast cleaned to SSPC 10, near white finish.
2. All external surfaces of fabricated parts shall be coated with one layer of polyurethane primer, 2.5 to 3.5 mils dry film thickness and one layer of aliphatic acrylic polyurethane, 2 to 3 mils dry film thickness.
3. The standard color is gray.

G. Design and manufacturing standards:
1. All calculations of gear and bearing life shall be made in accordance with the latest AGMA and AFBMA standards.
2. Welding fabrication and design are in accordance with the latest AWS standards.
3. Power train calculations of all components are available upon request in accordance with specification details listed above.

F. All lubrication shall be of the totally enclosed oil bath and grease design.

G. The drive shall be model SX-BL manufactured by DBS Manufacturing, Inc. or approved equal.

Product Data:

Overall Continuous Rating*	6000 ft-lbs
Overall Maximum Rating (Duty rating)	12000 ft-lbs
Alarm Torque Setting	100% of continuous torque or per customer specification
Cutoff Torque Setting	120% of continuous torque or per customer specification
Standard Rake Motor Horsepower	0.5 hp
Electric Power	460volts/60hz/3phase
Weight	900 lbs

* Continuous ratings are for 10-year life

2.09 SPARE PARTS

A. The following spare parts shall be provided;
   1. One (1) set of neoprene skimmer wipers for each mechanism.
   2. One (1) set of 304 stainless-steel scraper squeegees

PART 3 - EXECUTION

3.01 INSTALLATION

A. The equipment shall be erected in strict accordance with the manufacturer's recommendations.

3.02 SERVICE

A. The equipment manufacturer shall provide a service representative properly trained in inspection and operation of the mechanism to approve the installation, certify that the torque settings of the drive overload protection device are correct, witness the torque test (performed by others) and instruct the owner's personnel on maintenance and operation. If additional service is required due to the mechanisms not being fully operational, at the time of service requested by the contractor, the additional service days will be at the contractor's expense.

3.03 TORQUE TEST

A. The clarifier mechanism shall be field torque tested. The purpose of the torque test is to verify the structural integrity of the mechanism structural steel design and center drive unit. The testing shall be carried out under the supervision of the equipment manufacturer's representative and as approved by the Engineer before the mechanisms are accepted and placed into operation.

C. The torque test shall consist of securing the rake arms by cables to anchor bolts installed by the contractor in the tank floor at locations specified by the equipment manufacturer. A load shall be applied gradually to the scraper arm by means of a ratchet lever and cylinder connected to the cable assembly.

D. The magnitude of the applied load shall be measured by calculating the torque from the distance of the line of action of each cable to the center line of the mechanism. A reading shall be taken at the 100% value of the drive design torque.

E. The manufacturer's service representative shall verify that the alarm, motor cut-out, and backup safety motor cut-out switches are properly set and are in proper operation to protect the clarifier mechanism as specified.

END OF SECTION 11110

SECTION 11120 – PLANT DRAINAGE PUMP STATION

PART 1 - GENERAL

1.1 SCOPE:

A. The work to be done under this Division shall consist of furnishing all labor, materials, equipment, permits, and services necessary for the installation of a new plant drainage pump station including valve boxes, submersible sewage pumps, variable speed drives, piping, electrical and pump controls, and incidental materials and services listed, mentioned, or scheduled on the Drawings and/or herein for the completion of the lift station.

1.2 INSPECTION AND TESTS:

A. The Contractor shall obtain, at his own expense, all inspections required by law, ordinances, rules, regulations, or public authority having jurisdiction over the work which is a part of these specifications. He shall obtain certification of such inspections and submit them to the Engineer.

B. All control apparatus shall be properly calibrated and adjusted. Control panels shall be third party certified.

C. When the entire installation is complete and ready for operation and before final inspection, the Contractor shall operate the apparatus as directed by the Engineer for the purpose of testing the performance of the system and various equipment. All lines shall be tested before the pumps are tested.

D. Motors shall operate without undue noise or vibration. The system shall operate quietly and without undue noise on connections and take-offs and without undue vibration.

E. Any defects made manifest by the test shall immediately and promptly be corrected by the Contractor and the tests repeated.

F. All labor, materials, and equipment necessary for these tests shall be provided by the Contractor.

G. Provide Owner and Engineer with a written statement that manufacturer's equipment has been installed properly, commissioned, and calibrated and is ready for operation by the Owner. Secure manufacturer's certification that each control loop functions as required.

H. After receipt of written statement and approval by the Owner, provide authorized factory training for startup and maintenance services for not less than two 8-hour days at the jobsite (both sites) to train Owner's personnel. Include training for system operations.

1.3 WORKMANSHIP:

A. All material and equipment shall be installed and completed in a first-class workmanlike manner by craftsmen skilled in this particular work.

B. The Engineer reserves the right to direct the removal and replacement of any items which, in his opinion, shall not present an orderly and reasonably neat or workmanlike appearance, provided that such items can be properly installed in such orderly fashion by methods usual in such work. Such removals or replacements shall be done by the Contractor when so directed in writing by the Engineer.

1.4 DRAWINGS:

A. The drawings, as furnished by the Engineer, are diagrammatic, but shall be followed as closely as actual construction of the building and work of other trades will permit. All changes from these drawings necessary to make the work conform to the rules of legal bodies having jurisdiction shall be made by the Contractor.

B. The Contractor shall prepare or obtain from manufacturer certified shop drawings or erection drawings of all items of equipment to be furnished by him. The drawings shall be complete in fittings, piping, kinds and thicknesses of materials, weights, loading, required clearances for servicing and maintenance, etc.

1.5 QUALIFICATIONS:

A. All manufacturers proposing equipment described herein, shall provide a detailed submittal package which shall consist, at a minimum, all information and details prescribed below. All qualification submittals shall be submitted to the Engineer in writing.

B. If submitted equipment requires arrangement differing from that indicated on the drawings or specified, prepare and submit for review complete structural, mechanical, and electrical drawings and equipment lists showing all necessary changes and embodying all special features of equipment proposed. Any changes are at no additional cost to the Owner, and the Contractor shall be responsible for all engineering costs of redesign by the Engineer, if necessary.

C. Only those manufacturers capable of providing irrefutable evidence of a minimum of ten (10) years experience in the manufacture and installation of the exact model, or equivalent model, meeting the specified requirements shall be considered.

D. Qualification Requirements:

1. To be considered as an approved equal, the manufacturer will be regularly engaged in the manufacture of similar systems with a proven track record of at least twenty (20) operating installations of the proposed system.
2. The manufacturer will provide documentation of previous experience with municipal systems in wastewater applications.
3. Qualification submittals from manufacturers will include a complete and detailed proposal of equipment offered, including the number and model proposed, and a detailed description of any exceptions taken to the specification. Detailed drawings with pump plan views, sections, electrical wiring diagrams, technical specifications, dimensional drawings, pump curves, and other such applicable design documents shall be included in the package for review and approval.
4. Documentation of manufacturer's service capabilities including location, experience, and staffing personnel available.
5. If other equipment or setup arrangement is proposed, the Contractor will demonstrate and certify to the Engineer and the Owner that all requirements of materials, performance, and workmanship have been met or exceeded by the equipment proposed in the submittal documents. Any electrical, mechanical, structural or civil changes to the bid drawings required to obtain the specified requirements shall be designed and certified by qualified Professional Engineer(s) licensed in the State of Tennessee. Contractors proposing alternate manufacturers will be responsible for all costs associated with system evaluation and redesign including all electrical, mechanical and civil aspects of the installation as well as all costs required for the design to be stamped by Tennessee License Professional Engineer(s).
6. List of all deviations from the basis of design.

PART 2 – PRODUCTS

2.1 GENERAL:

The pump station work consists of the following:

1) Pumps and Controls
2) Electrical and Control Wiring
3) Piping

Sloping, Shaping, and Dressing:

The slopes of all excavated areas, ditches and embankments shall be so trimmed and shaped as to be in reasonably close conformity with the plans or as directed by the Engineer. Slope finished grade away from the wet-well and valve box areas.

Final Dressing:

This work shall consist of dressing all slopes to within reasonably close conformity to the lines and grades indicated on the plans, as directed by the Engineer and generally preparing the project for final inspection and acceptance.

Final dressing shall be performed by hand and machines to produce a uniform satisfactory finish to all parts of the embankments. The road bed, shoulders, ditches and slopes shall be shaped within reasonably close conformity to the specified lines and grades.

The entire site shall be cleaned of all weeds, briars and bushes.

Final dressing shall be performed prior to seeding operations.

Seeding:

The Contractor shall seed all areas of the sites disturbed by construction operations in accordance with Section 02480 of these Specifications. The Contractor must guarantee the growth of a viable stand of grass sufficient for adequate cover.

Valves and Piping:

The pipe connecting the wet-well to the valve box shall be Class 350 Ductile Iron. The pipe shall be laid on grade and shall be bedded in crushed stone to center of pipe and shall be air tested before final acceptance inspection. All other piping on the pump station site shall be installed in accordance with Section 02730 of these Specifications or as shown on the Drawings. It shall be installed at the location and grade as shown on the Drawings.

All connections where pipe enters or exits the pump basin shall be watertight. All piping hardware inside the valve box and wet-well shall be stainless steel.

Access to Equipment:

No part of the system which has to be serviced or repaired in the normal operation of the system shall be installed in a place inaccessible for servicing.

Space Limitation:

The Contractor's attention is called to the space available for this equipment and special care shall be taken in selecting equipment to fit the space available if other than specified equipment shall be proposed. Approval by the Engineer of alternate equipment shall be tested only on capacities, general construction and merit of manufacturer and it shall remain the responsibility of the Contractor to select equipment that will fit space provided and which can be installed to provide satisfactory operation and maintenance conditions.

Project Guarantee:

The Contractor shall furnish to the Engineer a two-year warranty at a minimum. All pump equipment and workmanship shall be guaranteed for a period of two (2) years from the date of completion. The Contractor shall provide the Owner a written guarantee that the work executed under this Section of materials and workmanship for a period as specified from the date of final acceptance. He further agrees that he will, at his own expense, repair and replace all such defective work, and all other work damaged thereby, which becomes defective during the term of this guarantee.

Discharge Piping:

Piping shall include swing check valves, eccentric plug valves and any necessary elbows and tees. Where piping passes through a wall, the joint shall be watertight.

Guide Rail Assembly:

The guide rail assembly and all hardware shall be constructed of Type 304 stainless steel and shall consist of a minimum of two rails, a bottom base plate (cast iron), a minimum of one cross brace every 18 inches between the rails and a wall brace all welded together to provide the maximum structural integrity. The rails shall be Schedule 40, 304 stainless steel and a minimum 2" round to provide a non-binding surface during installation and removal of the pump. Bigger size may be used as required by the pump manufacturer. The guide rail assembly shall be installed as a one-piece unit and shall be bolted to the basin bottom and the basin wall.

Pump Bracket Assembly:

The pump bracket assembly shall consist of a top bracket and a bottom bracket. The brackets shall be fabricated of 1/4" stainless steel material. The top bracket shall be attached to the discharge piping above the pump disconnect and shall be constructed in such a manner that pump cannot be removed from the guide rail assembly except when removing pump out the top of the sump basin. The bottom bracket shall be attached to the pump at the discharge connection and shall guide the pump along the guide rail assembly to insure proper alignment of the pump.

Lifting Chain:

A stainless steel lifting chain shall be furnished for lifting and lowering the pump in the sump basin. The stainless steel lifting chain shall be of the 304 stainless steel and shall have minimum nominal breaking strength of 3 times the weight of the pump. It shall be substantially attached to the top of the pump and shall have a formed loop at the other end.

2.2 PUMPS:

Operating Conditions & Pumps:

Furnish and install one (1) complete duplex pumping system.

Each system shall include two (2) submersible, explosion-proof (meeting NEC Class 1, Division 1, Groups C and D), non-clog sewage pumps, submersible pressure transducer (primary pump control), mercury switch level controls (backup pump control), variable speed drives, discharge plumbing with hydraulically sealed discharge flanges, pump mounting base elbows, bottom and upper stainless steel rail supports, stainless steel lifting chain, wiring channel, control panel, wet-well and valve box basins, and all other components shown on drawings.

The pumps shall be field installed in the existing precast concrete basin. Rails, piping, check and plug valves will be bolted in place to ensure alignment.

Requirements:

A. Pumps:

Furnish and install two submersible non-clog sewage pumps as shown on the plans. Each pump shall be equipped with a submersible electric motor connected for operation at (see Table below) volts, 3 phase, 60 hertz service, with a minimum of 50 Ft. jacketed cable suitable for submersible pump applications. The pump shall be supplied with a mating cast iron discharge elbow and capable of delivering the stated flows. Each unit shall be fitted with 30 feet of stainless steel lifting chain to permit raising and lowering the pump.

B. Pumps shall meet the following specifications:

Specification	Unit
Flow (GPM)	550
TDH (ft)	50
Voltage/Phase	460/3

C. Pump Construction:

Major pump components shall be of gray cast iron, (ASTM A-48, Class 35B) with smooth surfaces devoid of porosity or other irregularities. All exposed fasteners shall be stainless steel 1.4401 (AISI type 316) construction. All metal surfaces coming into contact with the pumped media (other than the stainless steel components) shall be protected by a factory applied spray coating of high solids two-part epoxy paint finish on the exterior of the pump. The pump shall be equipped with an open lifting hoop suitable for attachment of standard chain fittings, or for hooking from the wet well surface. The hoop shall be of stainless steel 1.4462, and shall be rated to lift a minimum of three times the pump weight.

Sealing design for the pump/motor assembly shall incorporate machined surfaces fitted with Nitrile (Buna-N) rubber O-rings. Sealing will be the result of controlled compression of rubber O-rings in two planes of the sealing interface. Housing interfaces shall meet with metal to metal contact between machined surfaces, and sealing shall be accomplished without requiring a specific torque on the securing fasteners. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered equal. No secondary sealing compounds shall be required or used.

Impeller: The impeller shall be of gray cast iron, (ASTM A-48, Class 35B). The impeller shall be of the semi-open, non-clogging, single vane design, meeting the Ten State Standards requirement for minimum solids passage size of 3 inches. The impeller shall be capable of passing a minimum of 4.7-inch diameter spherical solids as are commonly found in waste water. The impeller shall have a slip fit onto the motor shaft and drive key, and shall be securely fastened to the shaft by a stainless steel bolt which is mechanically prevented from loosening by a positively engaged ratcheting washer assembly. The head of the impeller bolt shall be effectively recessed within the impeller bore or supporting washer to prevent disruption of the flow stream and loss of hydraulic efficiency. The impeller shall be dynamically balanced to the ISO 10816 standard to provide smooth vibration free operation. Impeller designs which do not meet the Ten State Standards requirement for 3 inch solids passage size, those that rely on retractable impeller designs to pass 3 inch solids, or those that rely on fins or pins protruding into the suction path to assist in the handling of fibrous material shall not be considered equal.

Self-Cleaning Wear Plate: The wear plate shall be constructed from gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B). The wear plate shall be designed with an inlet incorporating strategically placed cutting grooves and an outward spiral V-shaped groove on the side facing the impeller, to shred and force stringy solids outward from the impeller and through the pump discharge. The wear plate shall be mounted to the volute with four stainless steel securing screws and four stainless steel adjusting screws to permit close tolerance adjustment between the wear plate and impeller for maximum pump efficiency. Adjustment to allow for wear and restore peak pumping performance shall be easily accomplished using standard tools, and without requiring disassembly of the

pump. The use of fixed or non-adjustable wear plates or rings, or systems that require disassembly of the pump or shimming of the impeller to facilitate adjustment shall not be considered equal or acceptable.

Pump Volute: The pump volute shall be single piece gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) non-concentric design with centerline discharge. Passages shall be smooth and large enough to pass any solids which may enter the impeller. Discharge size shall be as specified on the pump performance curve. The discharge flange design shall permit attachment to standard ANSI or metric flanges/appurtenances. The minimum working pressure of the volute and pump assembly shall be 10 bar (145 psi).

Premium Efficiency Motor:

The Premium Efficiency motor shall meet efficiency standards in accordance with IEC 60034-30, level IE3 and NEMA Premium*. Motor rating tests shall be conducted in accordance with IEC 60034-2-1 requirements and shall be certified accurate and correct by a third party certifying agency.

The Premium Efficiency motor shall be housed in a water tight gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) enclosure capable of continuous submerged operation underwater to a depth of 20 meters (65 feet), and shall have an IP68 protection rating. The motor shall be of the squirrel-cage induction design, NEMA type B, Premium Efficiency. The copper stator windings shall be insulated with moisture resistant Class H insulation material, rated for 180^{o}C (356^{o}F). The stator shall be press fitted into the stator housing. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is unacceptable. The rotor bars and short circuit rings shall be made of cast aluminum.

The motor shall be designed for continuous duty. The maximum continuous temperature of the pumped liquid shall be 40^{o}C (104^{o}F), and intermittently up to 50^{o}C (122^{o}F). The motor shall be capable of handling up to 15 evenly spaced starts per hour without overheating. The service factor (as defined by the NEMA MG1 standard) shall be 1.3. The motor shall have a voltage tolerance of +/- 10% from nominal, and a phase to phase voltage imbalance tolerance of 1%. The motor shall have a NEMA Class A temperature rise, providing cool operation under all operating conditions. The Premium Efficiency Motor shall be FM and CSA approved for use in NEC Class I, Division I, Groups C & D hazardous locations. The surface temperature rating shall be T3C. The motor shall meet the requirements of NEMA MG1 Part 30 and 31 for operation on PWM type Variable Frequency Drives.

The motor shall be capable of operating, completely submerged, partially submerged, or unsubmerged. For submerged (wet pit) applications, the motor shall be self-cooling via the process fluid surrounding the motor.

Thermal Protection: Each phase of the motor shall contain a normally closed bi-metallic temperature monitor switch imbedded in the motor windings. These thermal switches shall be connected in series and set to open at 140ºC +/- 5ºC (284ºF). They shall be connected to the control panel to provide a high stator temperature shutdown signal, and are used in conjunction with external motor overload protection. Bi-metallic temperature switches shall be available for the upper and lower bearings to provide high bearing temperature warning signals. As an alternate, RTD (PT100) type temperature measuring devices shall be available for the motor winding and bearings to provide actual temperature measurement at these locations. When the RTD option is supplied for the motor winding, bi-metallic switches shall also be supplied in the winding. The bi-metallic system must be connected to the control to provide positive shutdown of the motor in the event of an overheat condition. This is required in order to conform to FM and CSA rules for explosion proof equipment.

Mechanical Seals: Each pump shall be equipped with a triple seal system consisting of tandem mechanical shaft seals, plus a radial lip seal; providing three complete levels of sealing between the pump wet end and the motor. The mechanical seal system shall consist of two totally independent seal assemblies operating in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The mechanical seals shall be of non-proprietary design, and shall be manufactured by a major independent manufacturer specializing in the design and manufacture of mechanical seals. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary industrial duty solid silicon-carbide seal ring and one rotating industrial duty solid silicon-carbide seal ring. The stationary ring of the primary seal shall be installed in a seal holding plate of gray cast iron EN-GJL-250 (ASTM A-48, Class 35B). The seal holding plate shall be equipped with swirl disruption ribs to prevent abrasive material from prematurely wearing the seal plate. The upper, secondary seal unit, located between the lubricant chamber and the sensing chamber, shall contain one stationary industrial duty solid silicon-carbide seal ring, and one rotating one rotating industrial duty solid silicon-carbide seal ring. Each seal interface shall be held in contact by its own spring system. A radial lip seal shall be positioned above the sensing chamber, preventing any liquid which accumulates in the sensing chamber from entering the lower bearing and motor. The seals shall not require routine maintenance, or adjustment, and shall not be dependent on the direction of rotation for proper sealing. Each pump shall be provided with a lubricant chamber for the shaft sealing system which shall provide superior heat transfer and maximum seal cooling. The lubricant chamber shall be designed to prevent overfilling, and to provide lubricant expansion capacity. The drain and inspection plug shall have a positive anti-leak seal, and shall be easily accessible from the outside of the

pump. The seal system shall not rely upon the pumped media for lubrication and shall not be damaged when the pump is run dry. Lubricant in the chamber shall be environmentally safe non-toxic material.

Mechanical Seal Protection System:

The primary mechanical seal shall be protected from interference by particles in the waste water, including fibrous materials, by an active Seal Protection System integrated into the impeller. The back side of the impeller shall be equipped with a sinusoidal cutting ring, forming a close clearance cutting system with the lower submersible motor housing or seal plate. This sinusoidal cutting ring shall spin with the pump impeller providing a minimum of 75 shearing actions per pump revolution. Large particles or fibrous material which attempt to lodge behind the impeller or wrap around the mechanical seal, shall be effectively sheared by the active cutting system into particles small enough the prevent interference with the mechanical seal. The Seal Protection System shall operate whenever the pump operates, and shall not require adjustment or maintenance in order to function.

Seal Failure Early Warning System: The integrity of the mechanical seal system shall be continuously monitored during pump operation and standby time. An electrical probe shall be provided in a sensing chamber positioned above the mechanical seals for detecting the presence of water contamination within the chamber. The sensing chamber shall be air filled, and shall have a drain / inspection plug with a positive anti-leak seal which is easily accessible from the outside of the pump. A solid-state relay mounted in the pump control panel or in a separate enclosure shall send a low voltage, low amperage signal to the probe, continuously monitoring the conductivity of the liquid in the sensing chamber. If sufficient water enters the sensing chamber through the mechanical seal system, the probe shall sense the increase in conductivity and signal the solid state relay in the control panel. The relay shall then energize a warning light on the control panel, or optionally, cause the pump shut down. This system shall provide an early warning of mechanical seal leakage, thereby preventing damage to the submersible pump, and allowing scheduled rather than emergency maintenance.

Two (2) additional moisture sensing probes, one in the electrical connection chamber, and one in the motor chamber shall be available. These probes shall send separate signals to the control panel as described above, so that maintenance personnel are given an early warning of the presence of moisture in the respective sensing chambers.

Shaft: The pump shaft and motor shaft shall be an integral, one-piece unit adequately designed to meet the maximum torque required at any normal start-up condition or operating point in the system. The shaft shall have a full shutoff head design safety factor of 1.7, and the maximum shaft deflection shall not exceed .05 mm (.002 inch) at the lower seal during normal pump operation. Each shaft shall be stainless steel 1.4021 (AISI 420) material, and shall have a

polished finish with accurately machined shoulders to accommodate bearings, seals and impeller. The shaft shall be available in stainless steel 1.4462 (UNS S31803). Carbon steel, chrome plated, or multi piece welded shafts shall not be considered adequate or equal.

Bearings: Each pump shaft shall rotate on high quality permanently lubricated, greased bearings. The upper bearing shall be a cylindrical roller bearing and the lower bearings shall be a matched set of at least three heavy duty bearings, two angular contact ball bearings and one cylindrical roller bearing. All three lower bearings shall have identical outer race diameters to provide maximum bearing load capacity. Designs which utilize a roller bearing with a smaller outer diameter than the other bearings in the assembly do not provide maximum load capacity and shall not be considered equal. Bearings shall be of sufficient size and properly spaced to transfer all radial and axial loads to the pump housing and minimize shaft deflection. L-10 bearing life shall be a minimum of 100,000 hours at flows ranging from ½ of BEP flow to 1½ times BEP flow (BEP is best efficiency point). The bearings shall be manufactured by a major internationally known manufacturer of high quality bearings, and shall be stamped with the manufacturer's name and size designation on the race.

Power Cable: The power cables shall be sized according to NEC and CSA standards and shall be of sufficient length to reach the junction box without requiring splices. The outer jacket of the cable shall be oil, water, and UV resistant, and shall be capable of continuous submerged operation underwater to a depth of 65 feet.
Cable Entry/Junction Chamber: The cable entry design shall not require a specific torque to insure a watertight seal. The cable entry shall consist of cylindrical elastomer grommets, flanked by stainless steel washers. A cable cap incorporating a strain relief and bend radius limiter shall mount to the cable entry boss, compressing the grommet ID to the cable while the grommet OD seals against the bore of the cable entry. The junction chamber shall be isolated and sealed from the motor by means of sealing glands. Electrical connections between the power cables and motor leads shall be made via a compression or post type terminal board, allowing for easy disconnection and maintenance.

2.3 PUMP CONTROLS AND OPERATION:

Control and Instrumentation Equipment:

A. Intent:

The Contractor shall furnish, install, and place into successful operation a level control systems designed to automatically control the operation of two submersible pumps.

B. References:

The entire system shall be constructed in strict accordance with the latest published standards of NEMA, IEEE and ANSI. Wherever possible, control system components shall be Underwriters Laboratory listed. All control hardware and software shall be factory assembled, wired and thoroughly tested prior to shipment.

C. 3rd Party Approval:

The control panels shall bear serialized UL 508 "Enclosed Industrial Control Panel" label. If provided, the main power circuit breaker shall be rated as suitable for use as a service entrance.

D. Experience:

All of the equipment listed herein shall be furnished by a single supplier with at least ten (10) years experience in furnishing comparable systems and shall be of the latest and most modern design. The supplier shall be responsible for the correct operation of the equipment as specified.

E. Submittal:

The Contractor shall submit six (6) complete sets of the following information for the Engineer's approval: Dimension drawings, wiring and/or hydraulic drawings for field and pipeline mounted equipment. Fabrication and nameplate legend drawings, internal wiring and piping schematic drawings, system schematic drawings illustrating all components being supplied, with complete pneumatic and electrical connections. Actual system schematic drawings shall be provided. Manufacturers catalog cuts or standard drawings merely showing "typical" circuitry are not acceptable.

F. Integration:

The control system supplier shall work closely with the pump supplier to provide a single integrated set of schematic drawings for this project.

G. Equipment Supplier:

The equipment described below is a standard product of the Healy-Ruff Corporation, Inc. The purpose of specifying this equipment was to establish a minimum standard for the equipment to be provided. Equal suppliers will be considered. The submittal shall include descriptive literature, dimensions, and any exceptions to these specifications.

Pre-approval does not relieve the supplier of the system from the responsibility of meeting the plans and specification in every hardware

detail and software function. If an alternate control system is substituted for the specified system and the owner or the engineer later determines that the system is not meeting the intent of the specifications, with respect to reliability, efficiency, functional capability, or other system parameters, the contractor shall remove that part of the work that has been completed and replace it with the specified control system at the contractor's expense. This requirement shall continue in effect until one year after final acceptance.

Description of Operation:

An H-O-A switch shall be furnished on the control panel for each pump installed.

In the "Hand" mode, the operator will manually start and stop each of the pumps. The pump speed will be at a preset speed selected on the VFD by the operator.

In the "AUTO" position, the pumps shall start and stop based on the VFD settings and the water level in the wet-well. See description below:

A. Automatic Wet-Well Level Control:

The primary level sensor (submersible pressure transducer) shall monitor wet well level continuously. The pump/s shall start and stop as required to maintain an acceptable level. When the level in the wet well rises to the lead pump start setpoint, the lead pump shall be started.

Its speed shall vary between the simplex minimum speed and maximum speed control level set points. The pump shall first start and operate at its minimum speed. Its speed shall increase proportional to the water level rise in the wet-well. If the capacity of the lead pump running at the maximum speed is greater than the influent flow, the lead pump shall stop when wet well level falls to the common pump stop set point. If the capacity of the lead pump running at the maximum speed is less than the influent flow, the water level in the wet-well will rise and the lag pump will start. The speed of both the lead and lag pumps shall be equally reduced from 100% to 50% so both pumps can equally accelerate with any additional incoming flow. If the water level falls to the common pump stop setpoint, both pumps will stop. If the capacity of lead and lag pump running at their maximum speed is less than the influent flow (i.e. the water level keeps rising), the high water alarm setpoint will come on.

Upon main control failure (i.e. Transducer), the back-up control system (i.e. mercury float system) shall assume all control. When the high, high float switch is activated, the back-up controller shall come on line, and it will lock-out the primary control, until manually reset by the operator. A

pilot light shall indicate on the control panel when the back-up control system is operating.

In the backup controlled mode, the pump speed will be at its maximum preset speed. There will be no automatic variable speed utilized under this mode. The plant operator shall be able to manually alter the pump speed from the VFD as needed.

A horn silence push button shall be provided below the external alarm horn. Pressing the silence push button shall silence the alarm horn and cause the external alarm light to go to a steady on state.

During low flow scenarios, an adjustable range timer (0 to 120 minutes) shall be installed to operate the lead pump at set intervals if the liquid level has not reached start level. Operation from level transducer shall reset timer. Preset timer to 45 minutes.

Alternation: The pumps shall be programmed to alternate after each complete pumping cycle or after 12 hours of continuous operation of one pump. Alternation and all such necessary controls and instrumentation shall be provided for both primary and backup control systems.

Alternate Electric Power: When operating on standby power, operation shall be based on both pumps running.

B. Interlocks & Failure Circuits:

The pumping system consists of two (2) pumps of equal horsepower. If one or more pumps are being operated in Hand, the number of pump steps available for automatic operation shall be reduced by that amount.

The VFD supplier shall supply an HOA not in Auto contact to the pump control panel for each of the VFDs supplied. If a pump running signal input is not received within 30 seconds (adjustable) of being called to start a pump failure alarm shall be annunciated. The respective pump shall be removed from the alternation scheme and the next pump in sequence shall operate in its place. The pump shall remain cutout until the failure condition has cleared and the reset button has been pressed.

C. Primary Pump Controller:

Primary pump controller shall be from Siemens Water Technologies IntraLink LC2000 controller, or equal, to be mounted in a control panel enclosure by the system integrator. The controller shall be provided with an operator interface terminal (IntraLink OI3000 OIT or equal) to provide analog/digital status and alarm contacts to be monitored by the future

telemetry system. Other equal pump/telemetry controllers such as the Energy View Controller by Primex Controls, Multismart (with flow calculations, VFD control algorithm, and Motor Protection) by MultiErode will be considered. All pump controllers specified (regardless of brand) shall be furnished with a battery backup system, and removable, secure digital (SD) card.

Pilot Devices:

A. General:

Selector switches shall include removable 10 amp, 600-volt double make double break contacts. All pilot lights, selector switches and pushbuttons shall be rated for NEMA/UL 4X applications. They shall be not less than 30.5 mm diameter. All pilot devices shall be manufactured by Allen Bradley, or equal.

B. Relays & Timers

Relays shall be general-purpose plug-in type. They shall be a minimum of 3-pole, double-throw with contacts rated for 10 amps at 240 VAC. All relay sockets shall be 11-blade to allow for future expansion. Timers shall be double-pole, double-throw, and solid state plug-in type. With contacts rated for 5 amps at 240 VAC. Sockets shall be eight-pin octal types. Timers shall be adjustable from 1-1023 seconds in one-second increments. A "time cycle in progress" indicating LED shall be provided. Relays and timers shall be manufactured by Allen Bradley, or equal.

C. Running Time Meters:

An elapsed time meter shall be mounted on the enclosure door for each pump. It shall be 6-digit (99999.9 hours) non-reset type. Each pump run signal shall be derived from a motor running output from the VFD.

D. Variable Frequency Drives:

1) General

VFD system selection and sizing: Provide a VFD system for each pump with sufficient capacity to supply 125% of rated output of the Wastewater Pump motors and meet all other requirements of this specification.

2) Quantity

VFD systems are required for the two (2) wastewater pumps

operating in the wet-well basin and as defined by the drawings.

3) Power Factor Correction

Provide VFD system that presents a load with 95 percent lagging power factor to the Power Supply System for a motor running with a full load power factor of 70 percent. The corrected power factor must NOT be leading under any operating condition.

4) Mechanical Resonance

Provide VFD with frequency controls programmed to avoid continuous operation at or near any critical frequencies of the pump and motor system.

5) Basic Description

a) The controller shall produce an adjustable AC voltage/frequency output. It shall have an output voltage regulator to maintain correct output V/Hz despite incoming voltage variations.

b) The controller shall have a continuous output current rating of 125% of motor nameplate current.

c) The VFD shall be of the Pulse Width Modulated type and shall consist of a 6-pulse full-wave diode bridge converter to convert incoming fixed voltage/frequency to a fixed DC voltage. The Pulse Width Modulation strategy shall be of the space vector type implemented in a microprocessor, which generates a sine-coded output voltage.

d) The phase shift transformers required to produce the 6-phase input to the pulse recifier shall be factory wired and mounted within the VFD enclosure as an integral part of the VFD assembly. External transformers shall not be required.

e) The inverter output shall be generated by power transistors which shall be controlled by six identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine-wave operation.

6) Basic Features

The VFD controller shall have the following basic features:

a) The keypad of each power unit shall include a “POWER ON” light, a VFD fault light, a VFD run light, manual stop pushbutton, manual start pushbutton, a fault reset pushbutton, an “AUTOMATIC” pushbutton and increase/decrease pushbuttons.

b) The VFD shall be software programmable to provide automatic restart after any individual trip condition resulting from over-current, over-voltage, under-voltage, or over-temperature. For safety, the drive shall shut down and require manual reset and restart if the automatic reset/restart function is not successful within a maximum of three attempts within a short time period.

c) A speed droop feature shall be included which reduces the speed of the drive on transient overloads. The drive is to return to set speed after transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive is to automatically compensate to prevent drive trip.

d) Automatic restart after drive trip or utility failure. Software selectable if not desired.

e) Speed profile: Individual adjustable settings for start, stop, entry, slope, and minimum and maximum speed points.

f) Process signal inverter: Software selectable to allow speed of drive to vary inversely with input signal.

g) A critical speed avoidance circuit will be included for selection of two critical speeds with a rejection band centered on that speed. The drive will ignore any speed signals requiring drive operation within the rejected band.

h) Proportional and integral set-point process controller with menu driven selection and programming via door-mounted keypad.

i) Pick up a spinning load: The VFD shall be able to determine the motor speed and resume control of a motor, which is spinning in either direction without tripping.

E. Backup Pump Controller:

Pump operation shall be enabled/disabled by 5 float switches with intrinsically safe barriers. Each intrinsically safe barrier shall include an input closed LED. Red LED's shall indicate alarm input closed. Green LED's shall indicate pump called for float input closed. An amber LED shall indicate stop float input closed. Form "C" output contacts shall be provided for high and low level alarm. Normally open contacts shall be provided for pump control. Red LED's shall be provided to indicate alarm output on and green LED's shall be provided to indicate pump control output on. Output contacts shall be rated for 10 amps @ 120 VAC.

Selector switches shall be provided to select pump sequence (1-2/Auto/2-1), simplex or duplex operation, all pumps start enable on high level, N.O. or N.C. low level float input, alarm flashing or non-flashing outputs.

A 0-3-minute adjustable time delay shall be provided to delay the starting of each pump. The lead pump start time delay shall be factory set at 5 seconds. The lag pump start time delay shall be factory set at 10 seconds.

A 0-3 minute off delay timer shall be provided to prevent the lead pump from short cycling if the low level and common stop float switch fail to close.

All LED, selector switch and timer functions shall silkscreened on the chassis.

F. Intrinsically Safe Barrier:

All float switches and transducers located in the wet well shall be provided with intrinsically safe barriers that meet UL 913 specification.

G. Motor Circuit Breakers:

Each pump motor and VFD shall be provided with a circuit breaker. Circuit breakers shall be thermal magnetic, "E" frame or better. A door interlocked, padlockable operating handle shall prevent the enclosure door form opening, when any pump circuit breaker is in the ON position. A defeat mechanism shall be included on the operating handle for use by authorized service personnel. Overload reset operators shall be provided to reset the overloads without opening the enclosure door.

H. Control Circuit Breaker:

Provide a door mounted 15-Amp control power circuit breakers for each controller, HVAC system, future SCADA panel, horns and light alarms, and all other pump enclosure circuits.

I. Transformers:

The primary and back-up controllers shall have separate independent power sources. Each transformer shall be able to provide enough power for all loads plus an extra 1000VA. Transformers shall have primary and secondary fusing and be mounted inside the control enclosure if possible.

J. A lightning-transit protector shall be provided. The device shall be a solid state device with a response time of less than 5 nano-seconds with a withstanding surge capacity of 6500 amperes. Units shall be instant recovery, long life and have no holdover currents.

K. Appropriately sized condensation heater and thermostat shall be furnished by system integrator, inside the control enclosure.

L. All installed devices shall be permanently identified with engraved legends.

M. Submersible Pressure Transducer:

The transducer body shall be manufactured from 316 stainless steel and include a 2½" convoluted VITON diaphragm. It shall be filled with Dow Corning series 200 silicone oil, or equal. Transducer accuracy shall be ± 1% of full scale including linearity, hysteresis and repeatability over a temperature range of 32 to 122 degrees F. The transducer shall be provided with sufficient cable to reach the control panel and shall not be spliced. An intrinsically safe barrier shall be provided. The transducer shall be installed inside a PVC stilling well supplied by the transducer manufacturer.

N. Convenience Outlet:

A 20 Amp, duplex, GFI receptacle and circuit breaker shall be mounted on the door of the enclosure. If the power to the control panel is 240 or 480 VAC, 3-phase, 3-wire, a control transformer sized 1 KVA above the system full load requirements shall be provided.

O. Phase monitor relay, time mark, Model 269R, or equal shall be furnished and installed for each pump.

Alarms:

A. General:

When a pump alarm condition is active its respective pump symbol shall turn red. The pump symbol shall return to its normal state (green running, white off) once the alarm has been cleared and manually reset.

All of the other alarms and the pump alarms shall be displayed in red text in an alarm log when they are active. Once acknowledged, they shall be displayed in blue text. If an alarm condition clears before it is acknowledged, it shall be displayed in green text. If the alarm condition reactivates before it is acknowledged, a new alarm shall be displayed in the alarm log. Once an alarm has cleared and been acknowledged, it shall be stored in an event log for future review by the operator. All alarms shall be time and date stamped, and displayed in the alarm log in reverse chronological order.

The following alarms shall be monitored:

High Water Level Alarm
High High Water Level Alarm (Backup Control System Engaged)
Low Water Level Alarm
Pump No.1 Failure - Alarm
Pump No.2 Failure- Alarm
Pump No.1 Overtemp - Alarm
Pump No.2 Overtemp - Alarm
Pump No.1 Seal Fail - Alarm
Pump No.2 Seal Fail - Alarm
Pump No. 1 VFD Fail - Alarm
Pump No. 2 VFD Fail - Alarm
Primary Pump Controller Failure – Alarm

B. Alarm Light and Horn:

An externally mounted common horn (90 db or more) and alarm light shall flash and sound when any of the noted alarms get tripped, or when any of the door-mounted alarm pilot lights turn on. The alarm light shall be 25-watt and include a red, heat resistant, unbreakable polycarbonate lens. Relamping of the alarm light shall be done from the inside of the enclosure

C. Transducer Failure:

Upon main control failure the back-up control system shall automatically assume all control. When the high, high water level float switch is activated, the back-up controller shall come on line, it will lock-out the

primary control until manually reset. A pilot light shall indicate when the back-up control system is operating.

Equipment Enclosure:

A. General:

All control and power equipment including the VFDs shall be mounted in a 14-gauge, 304 stainless steel NEMA/UL 4X climate controlled, wall and floor-mounted enclosure. The enclosure shall have a brushed #4 finish. All hinges shall be full-length, 11-gauge, piano type. Lift-off hinges are specifically not acceptable. All outer doors over 20" in height shall be provided with a pad lockable, 3-point latch system. A drip shield shall be provided over each outer door. Internal components shall be mounted on a heavy duty back plate. Heavy items shall be provided with mounting reinforcements as required. A sight glass window panel with sun shade shall be provided on the exterior door to view major components and the primary pump controller screen.

All selector switches, pushbuttons, pilot lights, motor starter overload reset operators and circuit breakers shall be operable and visible without opening the dead front inner door. The inner door shall be manufactured from 16-gauge, aluminum. The internal temperature must remain below 70 degrees Fahrenheit while operating in ambient temperature 114 degrees Fahrenheit, and full load conditions (two VFDs running). Refrigeration shall be used for cooling the cabinet. Thermal calculations shall be provided with shop drawing submittals for proper sizing of the ventilation system and related components.

Sizing of the control enclosure and ventilation calculations shall be by an approved system’s integrator.

PART 3 - EXECUTION

Installation:

The lift station and their installation shall be done in accordance with these Specifications, and in accordance with the current edition of the National Electric Code and the Tennessee State Building Code, where applicable. Oil filled pressure gauges with snubber and isolation valves shall be installed on each pump discharge line.

All pumps shall be site tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation or over-heating. The manufacturer along with their authorized representative shall conduct site tests. Tests shall include checking for correct rotation, maximum motor amperage draws within nameplate specifications, balanced voltages on each power leg with the pump operating to within manufacturers tolerances, and demonstrated compatibility of the pump/motor with the

controls supplied. Test results shall be in printed form and signed by the manufacturer or his Representative and supplied to the Owner.

Drawdown Testing:

Following installation, each pump in the pump station shall be subjected to a drawdown test or other similar testing procedure to confirm that the pump is operating at or near the required design operating point(s).

The drawdown test shall be performed in the presence of the Engineer or other authorized representative.

The results of all drawdown testing shall be maintained by the Engineer as part of the construction record documentation.
At a minimum, the following items should be covered:

The motor and seal housing chambers shall be hi-potted to test for moisture content and/or insulation defects.

Pump shall be allowed to run dry to check for proper rotation.

Discharge piping shall be attached, the pump submerged in water and amp readings shall be taken in each leg to check for an imbalanced stator winding. If there is a significant difference in readings, the stator windings shall be checked with a bridge to determine if an unbalanced resistance exists. If so, the stator will be replaced.

Electrical and Instrumentation/Control System Testing

The contractor shall ensure that a formal testing program of all electrical as well as instrumentation and control systems installed at the pump station is developed and performed.
At a minimum, the engineer or other authorized representative shall witness a field test of the pump station's electrical and instrumentation/control systems. The basic functions which shall be tested for operation as intended by the pump station design shall include, but shall not be limited to, the following:

Pump operational functions.
Level-sensing equipment.
Alarm System.

All testing of the electrical and instrumentation/control systems shall be performed in the presence of the Engineer or other authorized representative.

The results of all testing shall be maintained by the applicant as part of the construction record documentation.

Factory Tests:

A certified factory performance test shall be performed on each pumping unit in accordance with Hydraulic Institute Standards, latest edition. Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency relative to capacity from shutoff to 150% of design flow. A minimum of six points, including shutoff, shall be taken for each test. At least one point of the six shall be taken as near as possible to each specified condition. Results of the performance tests shall be certified by a Registered Professional Engineer and submitted for approval before final shipment.

Factory test instrumentation must include flow measuring with indicator; compound suction gauge; bourdon tube type discharge pressure gauge; electrical meters to measure amperes, volts, kilowatts and power factor; speed indicator and a vibrometer capable of measuring both amplitude and frequency.

A description of test equipment must be included with submittal data.

Spare Parts:

A complete replacement pump shaft seal assembly and installation instructions shall be furnished for each lift station.

The spare parts list (for each pump station) shall include, but not limited to, the following:

- One (1) – Cable Crommet
- Two (2) – O-Ring Kits
- One (1) – Upper Mechanical Seal
- One (1) – Lower Mechanical Seal
- One (1) – Upper Bearings
- Two (2) – Lower Bearings
- One (1) – Impeller Wear Ring
- One (1) – Inspection Plug Washer
- One (1) – Cable Entry Washer
- One (1) – Impeller Bolt
- One (1) – Impeller Key

Installation and Operating Instructions:

The supplier of pumps and controls shall further provide complete and detailed Installation, Operation and Maintenance Manuals per Section 01340. This manual shall cover at a minimum:

Approved shop drawings, including design data for all installed equipment and each major component and a pump curve/system curve analysis showing the design operating point(s).

Control panel wiring diagrams.

Warranty information for all installed equipment and each major component.

Inventory, functional descriptions, and complete operation instructions for all installed equipment and each major component.

Instructions for start-up/shut-down as well as for calibration and adjustment of all installed equipment and each major component.

Recommended maintenance management system, including preventative and predictive maintenance, for all installed equipment and each major component.

Contact information for local service companies as well as instructions for replacement of all installed equipment and each major component.

Contact information for local contractors capable of performing emergency repairs.

These manuals shall be made available upon start-up of the pump station.

The manufacturer shall provide the services of a factory-trained representative for a maximum period of one day to perform initial start-up of the pump station and to instruct the Owner's operating personnel in the operation and maintenance of the equipment.

The manufacturer shall have a minimum of five years-experience in the design and manufacture of pumps and shall guarantee for one year from date of start-up or eighteen months from date of shipment, whichever is shorter, that the equipment will be free from defects in design, material and workmanship. Warranties and guarantees by the suppliers of various components in lieu of a single source responsibility by the manufacturer will not be accepted. The manufacturer shall assume prime responsibility for the guarantee of the station and all components.

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

<u>Adjustments by Manufacturer:</u>

The manufacturer of the pumps shall supply necessary base plates, discharge fittings, influent pipe fittings, etc. to insure that the overall dimensions of the pump arrangement can be "piped" to the piping.

PART 4 – PUMP WARRANTY

The pump manufacturer shall warrant (pro-rated) the pump and motor to the Owner against defects in workmanship and materials for a period of five (5) years under normal use and service for municipal wastewater applications. A copy of each pump warranty shall be provided to the Owner at startup.

END OF SECTION 11120

SECTION 11130 - BLOWERS

PART 1 -GENERAL

1.01 SCOPE

A. Summary

The Manufacturer shall provide air bearing high-speed turbo blowers with integrated with a sound enclosure, PMSM motor, variable frequency drive, local control panel, pressure and temperature monitoring instrument, blow-off valve (BOV), and accessories for a complete operating system. Air bearings shall be uniquely designed and manufactured by the blower manufacturer.

The equipment shall be provided by a single manufacturer.

1.02 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer

a. Shall have not less than five (5) years experience designing and producing blowers.

b. Shall be certified for ISO 9001 and ISO14001.

c. Shall have a legal office or subsidiary in North America.

d. Manufacturer’s local representative to have a Professional Engineer licensed in the State of Tennessee, have a service shop located no less than 350 miles from the job site, and have a service team to provide technical assistance and troubleshooting capabilities as needed.

2. Codes and Standards

a. American Society for Testing and Materials (ASTM)

b. American Society of Mechanical Engineers (ASME PTC-10, Test procedures for centrifugal compressors and exhausters)

c. Canadian Standards Association (CSA)

d. Institute of Electrical and Electronic Engineers (IEEE)

e. Electrical and Electronic Manufacturers Association of Canada (EEMAC)

f. American Gear Manufacturers Association (AGMA)

g. Instrument Society of America (ISA)

h. Ontario Electric Safety Code (OESC)

i. Electrical Safety Authority Bulletins (ESA)

j. ISO 5389 Turbocompressor — Performance test code

1.03 SUBMITTAL INFORMATION

A. General Data

1. All submittal dimensions, calculations, and other information shall be in US units of measure.

2. All products required for submittal shall be provided in one complete package.

B. Submittal Data

1. Product Data

a. Blower data and cut sheets of components

b. Performance curves and indicating capacity and motor power over the range of operation

c. Blower weight and dimension

d. Certified anchor bolt layout drawing (if required)

e. List of spare parts for five (5) years of operation

f. Combined bill of materials (BOM) of components and equipment supplied.

g. Process & Instrumentation Drawings (P&IDs) showing all Inputs/Outputs (I/Os)

h. Any necessary dimensional drawings to coordinate piping layout with structural, architectural, electrical and or other mechanical work.

i. Core assembly specifications

i Motor Name plate data

ii Service factor of the motor

iii Efficiency at 100%,75%, and 50%

iv Power factor at 100% 75%, and 50%

v Features and specifications

2. Shop Drawings

a. Dimensional drawings of the blower

b. Instrumentation and control system schematics and wiring diagrams for electrical and control components

c. Local control panel drawing

d. Accessories and Appurtenances drawings

3. Quality Control and Testing

a. Current ISO9001 and 14001 certificate and UL/CSA certificates for the motor

b. Submit test report after fabrication, but prior to delivery of the blower

c. Submit detailed of testing plan with piping and instrumentation configuration according to ASME PTC10 or ASME PTC-13.

d. Test plan shall include

i Quality control procedures

ii Calibration certification

iii ASME PC10/13 test procedure and method of calculation results.

iv Functional test of package and components as necessary

e. Noise Level

i The maximum noise level at any point at 3 feet from the blower surface shall not exceed 85dBA.

ii The noise level shall be measured during the function test of the blower at the factory.

C. Operation and Maintenance Manuals

1. Provide installation and pre-operation check list

2. Indicate all scheduled maintenance requirements and routine inspections.

3. Provide a detailed of operation sequence. Provide typical operator interface screens with descriptions.

4. Provide a list of fault and error code with troubleshooting of the blower

5. Provide a list of recommended spare parts.

6. Provide service technical contact information

D. Warranty

Blowers shall be warranted against defects in material and workmanship for a period of (60) sixty-months from shipment. All other package components shall be warranted for a period of eighteen (18) months from delivery on site or twelve (12) months commissioning of the Blower system whichever occurs first.

E. Blower Environment

Blower enclosure shall be designed for outdoor installation.

PART 2 - PRODUCTS

2.01 GENERAL

A. The blower shall be constructed for continuous operation and shall be able to operate frequent start and stop for supplying air or gas at variable volumes without surge, vibration, or excessive heating of motor and variable frequency drive.

B. The blower shall be a single stage centrifugal air bearing high-speed turbo blower design.

2.02 DESIGN CONDITIONS

A. Standard Conditions

1. Pressure: 14.7 PSIA
2. Temperature: 95 deg F
3. Relative Humidity: 70%

B. Air Flow Requirement

1. Flow Rate of each blower (Design): 2,400 SCFM
2. Minimum Flow Rate of each blower: 750 SCFM
3. Discharge Pressure at Design Flow: 8 PSI
4. Motor BHP: 100.66
5. Motor Size: 125 hp

C. Blower

1. Duty: 1
2. Standby: 1

2.03 CONSTRUCTION OF BLOWERS

A. Blower

1. Shall be air foil bearings design and shall neither require oils nor lubricants for operation of the blower. Water cooling system is not acceptable.
2. Shall be separating process air and motor cooling air and shall not use the motor cooling air for processing air of the blower.

3. Shall use only filtered air for process air from the rear intake of the blower and shall not use front air intake air for processing.

4. Blower shaft shall be Inconel, and blower casting shall be spiral casing made of Aluminum casting.

5. Blower enclosure shall be graded IP 54 or NEMA 12 equivalent.

6. Vibration of the core in the blower shall be less than 4 mm/s.

7. Blower core shall be supplied with a UL/ULC certified standard

B. Impeller

1. Shall be 3-dimensional back-swept design with high efficiency configuration and shall be statically and dynamically balanced.

2. Shall be milled from forged AL7075 Aluminum Alloy.

3. Shall be at least 120% maximum allowable speed for the critical speed of the rotor system

4. Shall be connected directly to the rotor shaft.

C. Motor

1. Shall be certified for UL1004-1 or CSA 22.2 for the turbo blower core.

2. Shall be operated with 480V, 60Hz, 3Ph blower power input.

3. Shall be permanent magnet synchronises motor (PMSM) with H class insulation and 2 x Y winding configuration

4. Shall be a sufficient size for the duty without exceeding full-rated load over the entire operating range.

5. Shall be air cooling and shall not use any glycol or lubricant for the motor cooling.

6. Motor shall be protected from dv/dt filter.

7. Motor windings shall be provided with embedded RTD including spare temperature sensing and fault.

D. Variable Frequency Drive (VFD)

1. Each blower shall be equipped with a high efficiency VFD with 95~97% efficiency at full load.

2. VFD cooling fan shall not be installed, and VFD shall be cooled by the blower enclosure system.

3. Each VFD shall be selected and sized for required ranges of operation without any problems.

4. VFD shall comply with latest applicable standards and safety guidelines. If the Manufacturer can manage the motor temperature and blower performance, the sine wave filter or dv/dt filter shall not be required.

5. Harmonic Filter:

    a. Each VFD shall be supplied with a passive harmonic filter to comply with IEE519.

    b. Harmonic filter shall be mounted separately on the outside of the blower. If the main power supply of the blower is higher than 480V, auto transformer and harmonic filter shall be required remotely.

E. Blower Local Control Panel (LCP)

1. Blower shall include local control panel, PLC with Ethernet IP, SCADA or MCP communication protocol.

2. Blower LCP shall be pre-wired and pre-programed by the manufacturer.

3. Manufacturer shall provide LCD display touch screen, Human Machine Interface (HMI) located on the blower enclosure.

4. Blower LCP shall monitor and display the following on the screen and provide SCADA through Ethernet/IP communication. If additional analog I/O cards are installed, hard wired connection will transfer 4-20mA signal to the SCADA.

    a. Ambient Pressure

    b. Inlet Temperature

    c. Discharge Pressure

    d. Discharge Temperature

    e. Motor Speed

    f. Motor Temperature

    g. Motor Power

    h. Wire Power

    i. Discharge Flow

    j. Inlet/filter differential pressure

    k. Alarms and warnings

5. Blower LCP provide the following indicators on the screen:

    a. Blower Status: Run/Stop/ Fault

    b. Blower Mode: Local/ Remote

    c. Operation Mode: Constant Speed, Constant Flow, Constant Pressure, DO Mode

    d. Operation History

    e. Fault History

    f. Setup Menu

F. Blow-Off Valve (BOV)

1. BOV shall be integrated design with silencer and solenoid valve.

2. BOV shall be electronically controlled by a solenoid valve and controlled from the start and stop of the blower to protect surge.

3. BOV shall be controlled both electrically and pneumatically and shall not require any wiring and installation in the field.

G. Inlet Silencer

1. Blower shall be provided with an inlet silencer system integrally mounted to the blower enclosure. Intake high performance silencer performance losses shall be included by the blower Supplier in the blower performance calculation if ducted pipe type flanged inlet is connected to the Blower.

H. Accessories

1. Blower shall be supplied with one check valve for each discharge pipe. Check valve shall be dual disc type with center hinge, spring closure, cast iron body.

2. Blower shall be connected to the plant piping via flexible connectors. Flexible discharge connector shall be ANSI flange.

3. Blower shall be supplied with safety butterfly valve suitable for air service and temperature requirement. The valve shall be provided with a manual operator.

4. Inlet filters

PART 3 -EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All equipment shall be skid mounted or crated to protect against damage during the shipment. Finished surface of all exposed flanges shall be protected by shrink wrap.

B. Shipment is not to be made until Manufacturer coordinates shipment to the job site with the Contractor and Owner, assuring that all equipment will be properly received and stored.

C. Upon arrival at the site, store all equipment with heated and ventilated indoor space and avoid any high humidity environment

3.02 INSTALLATION

A. Comply with Manufacturer's installation and pre-operation instructions.

B. Manufacturer's authorized technician shall verify the installation and electrical connection before starting up the blower.

3.03 START-UP AND TRAINING

A. The manufacturer's representative or technician shall perform all necessary on-site support for installation supervision and acceptance testing under actual operating conditions. Manufacturer's representative to have qualification noted in Section 1.2.A.1.d

B. Acceptance test shall consist of a minimum of four (4) hours of operation of each blower verifying discharge flow, pressures, temperatures, and vibration of the blower.

C. Installed blower voltage and amperage readings will be taken for checking distortion level.

D. The manufacturer's representative or technician shall provide a written field test/start up report after completing testing.

E. Once acceptance testing is complete, the manufacturer's representative or technician shall perform a minimum of twenty-four (24) hours of on-site start-up support and operator training for the integration of the blower control system with SCADA system if required.

END OF SECTION 11130

SECTION 11160 - AC INDUCTION MOTORS

PART 1 GENERAL

1.1 SUMMARY

A. This specification covers integral horsepower squirrel cage AC induction motors.

B. This specification is intended to specify superior quality motors that provide consistent performance, highest efficiency, improved life cycle and lowest maintenance cost. The motors shall be built to provide the following:
   1. Safe operation.
   2. Highest efficiency.
   3. Reliability in an application, which may be corrosive and wet.
   4. Minimum maintenance requirement due to the design and quality of materials and workmanship.
   5. Lowest noise pollution.

C. Refer to the corresponding equipment specifications section(s) for additional motor requirements not covered in this section, applicable environmental conditions, and specific use of the motor.

1.2 DEFINITIONS AND ABBREVIATIONS

A. Definition of terms used in this specification shall be in accordance with NEC Article 100, ANSI//IEEE Standard 100, and UL Standards Glossary.

B. DE: Drive End, motor side.

C. Megger: The electrical test of the insulation resistance of an electrical motor at 500, 1000, 2500, or 5000 volts DC. This test is performed to detect insulation breakdown. Also, the term Megger is used to describe the test equipment used to perform the test.

D. ODP: Open drip-proof, motor enclosure.

E. ODE: Opposite Drive End, motor side.

F. RPM: Revolutions per minute.

G. RTD: Resistance Temperature Detector.

H. TEAO: Totally Enclosed Air Over, air-cooled motor enclosure.

I. TENV: Totally Enclosed Non-Ventilated.

J. TEBC: Totally Enclosed Blower Cooled, motor enclosure with separately powered blower.

K. TEFC: Totally Enclosed Fan Cooled, motor enclosure.

L. T'STAT: Thermostat, automatic reset high temperature thermal protector switch.

M. WP: Weather protected, motor enclosure.

1.3 STANDARDS AND CODES

A. Motor design and construction shall be in accordance with the latest applicable codes and standards of the following organizations.

1. ABMA American Bearing Manufacturers Association
2. ANSI American National Standard Institute
3. API American Petroleum Institute
4. ASTM American Society for Testing and Materials
5. CEE Consortium for Energy Efficiency
6. CSA Canadian Standards Association
7. IEC International Electrotechnical Commission
8. IEEE Institute of electrical and Electronics Engineers
9. NEC National Electrical Code
10. NEMA National Electrical Manufacturers Association
11. NESC National Electrical Safety Code
12. NETA National Electrical Testing Association
13. NFPA National Fire Protection Agency – National Electrical Code
14. SAE Society of Automotive Engineers
15. UL Underwriters Laboratories

B. All motors shall be listed under UL recognized component file.

C. All motors shall be CSA certified.

D. All motors shall be suitable for installation according to the requirements of NEC.

1.4 SUBMITTALS

A. Submittals shall be in accordance to Section 01 01 00 and 01 34 00.

B. Product Data: For each type of motor, provide dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, and characteristics.

C. Motor performance submittals for motor sizes 100 Hp and above, shall include the following additional manufacturer's data:
   1. Torque vs. RPM curves at 80% and 100% nominal line voltage.
   2. Motor performance – Percent Efficiency, Power Factor, Torque, RPM, Power (W) and Current (A) vs. Percent of rated power output (Horsepower) curves.
   3. Motor performance percent change - Percent Efficiency, Power Factor, Torque, RPM, Power (W) and Current (A) vs. Percent of line voltage variation curve.
   4. Motor Derating Factor vs. voltage percent unbalance curve.
   5. Motor thermal damage, logarithm inverse time vs. percent full load current curve.
   6. Harmonic Derating Factor vs. Harmonic Voltage Factor curve, based on typical adjustable speed drive input line distortion.
      a. Adjustable speed drive and motor shall be of Matched Performance type.
      b. Adjustable speed drive and motor shall be manufactured by the same company.
   7. Recommended power factor correction capacitor KVAR rating.
   8. Motor equivalent circuit with parameters values.
   9. Induction motor time constants:
      a. Open circuit time constant for power transfer switching surge analysis.
      b. Short circuit time constant and x/r ration for power system fault current analysis.

D. Shop Drawings: For each type and size motor,
   1. Include dimensioned drawings with mountings details, including required clearances and service space around equipment. Include the following:
      a. Each installed motor type and details.
      b. UL, CSA or other applicable agency listing.
   2. Wiring Diagrams to include power and auxiliary devices wiring.

E. Qualification Data: For testing agency and manufacturer.

F. Operation and Maintenance manual motor and all installed devices, and components to include the following:
   1. Manufacturer's instruction sheets.
   2. Manufacturer's installation instructions.

3. Manufacturer’s operating manual.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Motor manufacturer shall be based and headquartered in the United States of America and shall design and manufacture motors in the United States.
   2. Motor manufacturer shall have over 50 years-experience in the motor industry and shall maintain active company-wide quality assurance program.
   3. Motor manufacturer shall have corporate quality policy based on the customer perceived value formula.
   4. Motor manufacturer shall maintain an authorized service center capable of providing training, parts, and emergency maintenance and repairs. Distance between this center and the project site is specified elsewhere.

B. Motor design and performance shall comply with all applicable standards, the requirements of the equipment specifications (refer to applicable section elsewhere), and this section.

C. Motor performance shall be warranted against material and workmanship defects by manufacturer’s limited warranty and service policy for the period of at least of 18 months from the day of shipment from the factory or the manufacturer’s warehouse.
   1. Standard efficient motors shall be warranted for 24 months.
   2. Premium efficient motors shall be warranted for 36 months.
   3. Severe duty motors shall be warranted for 60 months.
   4. Extended warranty shall be offered for certain products or as agreed by additional terms.

1.6 DELIVERY, STORAGE AND HANDLING

A. Depending on motor size and weight, motors shall be packed in a secure carton and/or securely fastened to a hardwood skid or pallet for fork truck handling and shall be covered for protection against dirt and moisture during transit and outdoor storage. The motor container shall be clearly identified with permanent ink.

B. Store motor indoors in clean, dry space with uniform temperature to prevent condensation. Protect motor from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. Periodically, during storage, “Megger”, rotate the motor shaft and if available, apply power to motor space heaters, according to manufacturer’s instructions.

D. Handling shall be done with proper lifting equipment using lugs or eyebolts provided by the manufacturer.

1.7 COORDINATION

A. Coordinate layout and installation of motor with other equipment and machinery including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for motor cooling air, conduit box, lubrication spouts and coupling access.

B. Coordinate size and location of concrete bases for floor-mounted motors and make proper provisions for machinery-mounted motors.

C. Coordinate features of motor, installed units, and accessory devices with power and control circuits to which they connect.

D. Coordinate features, and accessories of each installed motor with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of controller and load.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Baldor Electric Company,
   2. US Motors,
   3. GE Motors, or equal.

2.2 TOTALLY ENCLOSED FAN-COOLED PREMIUM EFFICIENT AC INDUCTION MOTOR

A. Enclosures
   1. In general and unless otherwise noted in the equipment specifications, all motors shall be TEFC, NEMA T-frame, NEMA F1 assembly for horizontal (or vertical where noted or shown) applications and designed for the environment where the motor will be used. Where special enclosures or assembly are required, it will be specified in the equipment specifications section.

2. Enclosures shall be rolled steel band or cast iron construction depending on horsepower. End brackets shall be die cast aluminum with steel bearing inserts or cast iron construction. Conduit box shall be die cast aluminum or cast iron construction.
3. Motors shall have drain openings suitably located for the type assembly being provided.
4. For frames 215 and above, shouldered lifting eyebolts or cast provisions within the frame shall be furnished for handling convenience.
5. Motor enclosures shall have a bi-directional, spark-proof, abrasion and corrosive resistant fan made of a material that is strong and durable. Fan will be keyed to shaft on frames 254 and above.
6. Motor nameplate shall be embossed, made of stainless steel plate material, and mounted on enclosure with stainless steel fastening pins. Nameplate shall have, as a minimum, all information as described in NEMA Standard MG-1-20.60.
7. Motor bearing numbers shall be included on nameplate. Motor connection diagram shall be attached to motor and easily readable.

B. Motor Terminal Boxes and Leads:
1. Motor terminal boxes shall be sized larger than required by NEC or UL standards, pipe drilled for conduit and shall be attached to the motor frame with cadmium-plated hex head cap screws. Cover shall be installed with cadmium plated hex head cap screws. The conduit box shall come completely assembled to the motor.
2. Motor leads in the conduit box shall be sized in accordance with NEC suggested minimum ampacity values using a minimum of 125°C insulated lead wire. The wiring shall be clearly identified every inch or the lead shall have a metal band in accordance with ANSI C6.1, latest revision.
3. Motors shall be provided with a compression-type grounding lug mounted in the conduit box by drilling and tapping into the motor frame or by a double-ended cap screw of silicon bronze.

C. General Electrical and Mechanical Design Requirements:
1. All motors in general and unless otherwise noted, shall be premium efficiency, severe duty, NEMA Design B (normal starting torque, full voltage starting), squirrel cage, induction type, inverter-ready (per NEMA std MG1 Part 31.4.4.2), such as Baldor's Super-E Severe duty (ECP) motors, or equal. Where other designs or features are required, they will be specified on the equipment specification section.
2. Per NEMA MG 1 Part 12, Table 12-12, nominal minimum efficiencies for TEFC motors shall be equal to or greater than those shown below:

HP	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	77.0
1.5	87.5	86.5	84.0
2	88.5	86.5	85.5
3	89.5	89.5	86.5
5	89.5	89.5	88.5
7.5	91.0	91.7	89.5
10	91.0	91.7	90.2
15	91.7	92.4	91.0
20	91.7	93.0	91.0
25	93.0	93.6	91.7
30	93.0	93.6	91.7
40	94.1	94.1	92.4
50	94.1	94.5	93.0
60	94.5	95.0	93.6
75	94.5	95.4	93.6
100	95.0	95.4	94.1
125	95.0	95.4	95.0
150	95.8	95.8	95.0
200	95.8	96.2	95.4
250	95.8	96.2	95.8
300	95.8	96.2	95.8
350	95.8	96.2	95.8
400	95.8	96.2	95.8
450	95.8	96.2	95.8
500	95.8	96.2	95.8

3. Motors shall be wound for 200, 230, 460, 230/460 or 575-volt, three-phase, 60-hertz, 1.15 service factor.
4. Windings shall be copper magnet wire rated at 200°C and moisture resistant. Magnet wire insulation varnish must be of a type designed to resist transient spikes (such as Inverter Spike Resistant™ ISR), high frequencies, and short time rise pulses produced by inverters. Motor insulation system shall comply with NEMA MG_1-2003 Part 31.4.4.2.
5. Insulation shall be a Class F, non-hygroscopic varnish. The maximum permissible temperature for the insulation is not exceeded when the motor operates at service factor load in a 40°C ambient. Magnet wire shall have a service coating equivalent in thickness to a commercial “heavy” coating. The combination of magnet wire and varnish when tested in accordance with IEEE No. 57, latest revision, shall show a thermal rating of not less than 150°C for a duration of 30,000 hours life.

Normal temperature rise for 1.0 service factor operation shall not exceed a Class B rise.

6. Windings shall be firmly held in the stator slots to prevent coil shifts. Sharp edges and burs shall be removed from the stator core slots prior to inserting the winding. All coils shall be phase insulated using Nomex® paper or equal and laced down such that the windings will not move during repetitive starting. All stator connections will be securely made.
7. The insulation resistance of the sealed stator winding shall be greater than 100 megohms when measured at 25°C with a megohm bridge having 1000-volt direct current.
8. The motor design shall use the best available materials and methods to achieve premium efficiency, power factor and long life operation.
9. Motors shall be designed for operation in either direction of rotation without a physical change in the motor.
10. All motors shall have anti-friction, vacuum-degassed steel ball bearings electric motor quality. Grease fittings and reliefs are supplied for external lubrication while machine is in operation. Fittings and reliefs are plugged.
11. The bearings shall have a rated fatigue life of L-10 (B-10) of 150,000 hours for direct-coupled applications and 50,000 hours for belted applications minimum. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG_1-14.43. The calculation will be determined from the pulley centerline being at the end of the motor shaft.
12. The motor shall have tight mechanical bearing housing fits. Either the D.E. or O.D.E. bearing must be locked to limit axial shaft movement.
13. Bearing cavities and greasing passages shall be thoroughly cleaned of all debris before lubricating. Motors shall be lubricated at the factory with Exxon Mobil Polyrex™ EM grease or equal.
14. In general, motors 200-Hp and smaller, shall be inter-changeable for horizontal, vertical or belt-driven mounting. For 3600-rpm motors 30 horsepower and up, short shaft (NEMA TS) will be acceptable and is suitable for coupled loads only.
15. Maximum vibration allowed shall be 0.15 inches per second velocity measured at the bearing housings.
16. Rotor assemblies shall be die cast aluminum for NEMA frames. Rotors shall be keyed and shrunk or pressed to the shaft. Welding will not be acceptable. Keyed rotors shall be press-fitted on a shoulder the full length of the rotor utilizing the full shaft surface diameter.
17. Rotor shaft extension run out shall not exceed:
    0.002” TIR for shaft diameter 0.1875 – 1.625 inches
    0.003” TIR for shaft diameter over 1.625 – 6.500 inches

18. All shafts shall be precision machined from high-strength carbon steel suitable for belt and pulley drives (except as limited by 3600 RPM motors).
19. All motors shall have space heaters made from silicone rubber or be designed to operate at one half their rated voltage (if metallic or ceramic cartridges are used).
20. Motors from 50 Hp and up to 100 Hp shall include an AEGIS (866-738-1857) shaft grounding ring (SGR) kit. The SGR shall be installed on the DE of the motor to direct current away from the bearings and protect the bearings. Consult with the SGR manufacturer for specific equipment usage and proper kit selection.
21. All motors 20 Hp and up shall be equipped with thermal protection heat-sensing elements integral with the motor and an external control device.

D. Special Application Requirements as noted in the equipment specifications:
1. Extra Severe Duty Use (where specified)
For applications requiring a greater amount of weather and corrosion protection than the standard Baldor Super-E Sever Duty motor, Baldor Super-E Severe Duty IEEE 841 motors (ECP-841) or equal shall be used. The motor shall be built to close tolerances, supplied with certified test data, and be built to the latest IEEE 841 standards. These motors shall be supplied with Inpro/Seal® VBX bearing isolators on both the output and fan shafts. Motors shall be supplied with premium efficiency windings that exceed minimum efficiencies of the latest IEEE 841standard.
2. Hazardous Location Use (where specified)
Motors with UL and CSA listed enclosures shall be used in hazardous locations. Refer to the corresponding equipment specifications section for the proper class, group, division and temperature code motor to meet the requirements of such an installation.
3. Adjustable Speed Use (where specified)
    a. All adjustable speed motors controlled by variable frequency drives in general shall be of “inverter-duty” type, meeting the latest specifications defined by NEMA MG 1, Part 31. The motor shall be suitable for variable torque and with a constant torque 20:1 speed range. The manufacturer shall be notified on the requisition that the motor will be used in conjunction with a variable frequency drive. It shall be the responsibility of the motor manufacturer to ensure that this motor will be capable of operating under the torque requirements and speed range within temperature specifications.
    b. If the equipment duty cycle and speed range requires special design, the motor shall be Baldor Inverter-Drive™ or Vector-

Drive™ .These motors shall be designed for adjustable speed applications and shall meet all requirements of NEMA MG-1 Parts 30 and 31. Inverter Drive motors shall be suitable for variable torque applications and rated for 1000:1 for constant torque. Vector Drive motors shall be capable of full, rated torque at 0 RPM, continuous duty. Inverter drive motors shall be used for all centrifugal pumps, and centrifugal blowers/compressors. Vector drive motors shall be used for all mixers, conveyors, positive displacement pumps, and positive displacement blowers/compressors.

c. Any adjustable speed application required for a Division 1 or 2 hazardous locations shall use an Inverter-Duty™ Explosion Proof motor.

4. Motor sizes 100 Hp and up to 450Hp shall have one insulated bearing on the ODE and be equipped with a shaft grounding ring (SGR) on the DE, AEGIS SGR, with a ground strap from the motor to the drive case. Motors 500 Hp and above shall include both insulated bearings and an AEGIS iPRO SGR system.

E. Testing & Final Inspection

1. Electrical Tests

Each motor design shall receive the testing called out for “Polyphase Induction Motors and Generators”, IEEE 112, latest edition. The routine tests shall, as a minimum, conform to the NEMA MG 1 tests. In addition to the normal factory tests and those already covered in this specification, the following additional tests shall be performed for motor sizes 100 Hp and above:

a. The completed insulation system shall be capable of withstanding continuously a phase-to-ground rms voltage of 1000 volts minimum for a period of 30 minutes minimum.

b. The winding shall also be capable of passing a 2500 volt AC minimum, phase-to-ground test for one second.

c. Surge comparison test shall be performed using 3000 volts AC minimum; phase-to-phase comparison waveforms on the test unit shall be supplied.

d. Full load amperes, watts, power factor and RPM.

e. Locked rotor current at rated voltage.

2. Mechanical Inspection

a. Shaft runout shall be checked after the motor is completely assembled and recorded.

b. Inches/second velocity vibration data.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to mount motor for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of motor conduit boxes for motor power and motor auxiliary device connections before motor installation.

C. Proceed with installation only if all conditions are satisfactory.

3.2 APPLICATIONS

A. Select features of each motor to coordinate with ratings and characteristics of electrical power supply circuit, motor operating ambient conditions, motor running duty cycle, load starting and running torque demand, and review and coordinate necessary equipment for proper acceleration, deceleration and speed control requirements.

3.3 INSTALLATION

A. Prepare rigid foundation or mounting surface to minimize vibration and maintain alignment between motor and load shaft.

B. Align the motor shaft with driven equipment according to manufacturer's written instructions.

1. Flexible couplings for direct drive shall be accurately adjusted according to machine manufacturer's guidelines, use dial indicators to check alignment to minimize vibrations. Coupling spacing shall be according to coupling manufacturer guidelines.
2. Belt drive sheaves shall be aligned according to belt drive manufacturer's instructions to minimize belt ware and axial bearings loads. Belt tension shall be adjusted to prevent slippage at rated speed and rated load.
3. Adjust axial position of motor frame with respect to load shaft according to motor manufacturer's endplay adjustment guidelines recommended to minimize extensive external axial thrust loads.

C. Anchor each motor base to load bearing surface by carriage Grade 5 stainless steel bolts arranged and sized according to manufacturer's written instructions.

3.4 IDENTIFICATION

A. Read the motor nameplate data. Verify that rated voltage and frequency and motor rated full load current matches drawings, specifications, and application requirements.

B. Verify proper motor branch circuit and motor overload protection devices are installed in motor branch circuit as required by NEC Article 430.

C. Identify motor, conduit, power and auxiliary wiring according to Engineer's requirements and other applicable electrical systems and labor safety related requirements.

3.5 POWER CONNECTIONS

A. Install power cable conduits according to motor conduit box drawing and motor manufacturer's instruction. Install motor power supply cables and connects to motor power. All connections between motor and VFDs shall be enclosed in continuous metallic conduits and utilize appropriately sized and terminated PWM cabling system. Motor lead cable sizes shall be selected based on NEC and local code requirements.

B. Properly ground all equipment, motor frames, and VFDs (where applicable) according to manufacturer's recommendations regarding equipment ground and noise attenuation practices for electrical and electromagnetic interference.

C. Tighten electrical connectors and terminals according to cable and terminal manufacturer's published torque values.

3.6 AUXILIARY CONTROL WIRING INSTALLATION

A. Install wiring between motor auxiliary devices and associated controllers and protective devices according to manufacturer's instructions and information on motor nameplate.

B. Connections of devices sensitive to electromagnetic interferes such as RTD's, thermistors, thermal protector switches, vibration sensors and other applicable instrumentation wiring shall be made per manufacturer's instructions. Shielded conductors shall be used and routed in dedicated conduits, all in separate conduit runs end to end.

C. Install wiring to motor auxiliaries such as motor space heaters, motor blowers, and motor brake coils according to NEC power wiring requirements and according to motor manufacturer's instructions.

D. Good wiring practices shall be followed at all times.

3.7 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Verify mechanical installation is secure and all mounting hardware is tight according to manufacturer's recommended torque specifications.
   2. Inspect all electrical connections for proper termination, electrical clearances, mechanical strength and electrical continuity.
   3. Verify all shipping materials and braces are removed from the shaft. Verify that the motor and the coupled load are properly aligned, rotate freely and are not binding.
   4. Verify that maintenance information is posted. This information should include lubricants needed and preventative maintenance schedule.
   5. Verify that proper lubricants are readily available at the site.

B. Testing: Perform the following field quality-control testing:
   1. Test winding insulation integrity with a "Megger" or other insulation resistance tester.
   2. Apply power and verify rotation direction of the motor. Change the rotation direction if necessary and retest.

C. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.8 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that electrical wiring installation complies with manufacturer's submittal and Engineer's requirements.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.9 CLEANING

A. Clean motor externally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use blown compressed air to assist in cleaning.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to lubricate, clean, and maintain motor in proper operation condition.

END OF SECTION 11160

SECTION 11600 - INSTRUMENTATION

PART 1 - GENERAL

SCOPE: This section covers the furnishing and installation of instrumentation and control equipment which shall include the following principal items.

Panels and Subassemblies:

The Contractor shall furnish and install all required instruments and control panels.

Metering and Control Systems: Principal components of the metering and control systems shall be as indicated on the piping and construction drawings and as listed on the instrument device schedule drawings.

Miscellaneous: One lot of spare parts, and miscellaneous devices as set forth herein.

a. Duplicate full set of fuses for all devices furnished under this section containing user-serviceable fuses.

CODES, PERMITS, AND AGENCY APPROVALS: All work and materials shall comply with the National Electrical code (latest version) and applicable local regulations and ordinances. Where required by applicable codes, panel assemblies, materials, and equipment shall be approved, identified, labeled, or listed by Underwriters' Laboratories or other testing organization acceptable to the governing authority. The Contractor shall, at his own expense, arrange for and obtain all necessary permits, inspections, and approval by the proper authorities in local jurisdiction of such work. This shall include third party inspections or testing of panels and equipment as may be required by the governing authorities.

SUPPLIER'S QUALIFICATIONS: The instrumentation system shall be designed, coordinated, and supplied by a qualified system supplier who is regularly engaged in the business of designing and building instrument and control systems for water and wastewater projects. The Contractor's intended instrumentation supplier shall meet the following qualifications:

The supplier shall have and shall maintain a qualified technical staff and design office. The qualifications and experience of key project personnel shall be acceptable to the Engineer.

The supplier shall have the physical plant and fabricating personnel to complete the work specified. The supplier's fabrication capabilities and arrangements shall be acceptable to the Engineer.

The supplier shall employ competent service personnel to service the equipment furnished. The geographic location of service personnel for this project shall be acceptable to the Engineer.

The supplier shall have successfully provided similar work for at least 5 years.

The intended supplier shall provide the names of at least three references who are users of similar equipment designed, fabricated, and furnished by the supplier. References shall include a general description of the project scope and names and telephone numbers of persons to contact.

COORDINATION: Instrument and control systems shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications. All instruments and control devices shall be applied in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the instrument or device manufacturer and the manufacturer of related equipment.

Review of drawings submitted prior to the final determination of related equipment shall not relieve the Contractor from supplying systems in full compliance with the specific requirements of the related equipment.

Related equipment and materials may include, but will not be limited to, anoxic mixers (specification 11110), disc filter (specification11120), mechanical screen (specification 11350), spiral pressing unit (specification11400), equipment control enclosures, flow measuring devices, chart recorders, DO meters, analytical measuring devices, supervisory control equipment, telemetry, conduit, cable, and piping, as described in other specifications associated with this project.

Installation drawings shall be prepared for interconnecting wiring and piping between the related equipment and the equipment furnished under this section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system.

The Contractor shall provide coordination with other contractors and supervision of installation as required during construction. Location of control panels and other instrumentation on the Drawings is approximate. The final and exact location shall be field verified and approved by the Owner and Engineer prior to installation.

GENERAL REQUIREMENTS: All equipment furnished under this section shall be selected by the system supplier for its superior quality and intended performance. Equipment and materials used shall be subject to review and shall comply with the following requirements.

Power and Instrument Signals: Unless specified otherwise, electrical power supply to the instrumentation equipment will be unregulated 120 volts ac at the locations noted on the one-line and functional diagrams. All transmitted electronic analog instrument signals shall be 4-20 mA dc, unless noted otherwise, and shall be linear with the measured variable

Appurtenances: Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, and isolation requirements shall be furnished and installed as required for proper performance of the equipment.

Interchangeability and Appearance: Instruments used for the same types of functions and services shall be of the same brand and model line insofar as possible. Similar components of different instruments shall be from the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished. Recorders, process indicators, control stations, and similar panel-mounted instruments shall be of the same style and shall be products of the same major instrument manufacturer.

Programming Devices: A programming or system configuring device shall be provided for systems that contain any equipment which requires such a device for routine calibration, maintenance, and troubleshooting. The programming device shall be complete and in like-new condition and shall be turned over to the Owner at completion of startup.

Device Tag Numbering System: All devices shall be provided with permanent identification tags. The tag numbers shall agree with the instrument device schedules and with the supplier's equipment drawings. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered labels or tape labels will not be acceptable.

Special Tools and Accessories: Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

PART 2- PRODUCTS

2.1 Installation of LCD Control Panels: All LCD control panels shall be installed facing away from the sun unless otherwise protected by a properly shaded cabinet meeting the following requirements:

A. The product shall be manufactured by TRACOM, Inc.; 6575-A Industrial Way, Alpharetta, Georgia 30004; Toll-Free Voice (877) 435-8637, Toll-Free Fax (866) 435-8637, www.tracomfrp.com.

B. Requests for substitution must be made in writing and received by the engineer's office a minimum of ten (10) business days before bid opening.

C. Substitutions: Manufacturers not pre-approved shall not be allowed.

D. Warranty: Shades shall be warranted to be free of defects in workmanship and materials for a period of two years from shipment.

Instrument Shades:

A. Shade Type: Provide sunshades to meet the instrumentation requirements:
   i. Single-piece construction (sunshades).
   ii. Single-piece construction with marine grade plywood reinforcing panel laminated into the back of the shade:
      a. 1/2 inch thick (panel shades sizes 1.5-3)
      b. 3/4 inch thick (panel shades sizes 4 and 7).

B. Materials:
1. One-piece, fiberglass reinforced plastic.
2. Gloss inside surfaces, free of irregularities.
3. Minimum 3/16-inch wall thickness.
4. Minimum 30% glass by weight.
5. Isopthalic polyester resin.
6. All corners shall be of a smooth and with minimum radius of 1/4 inch.
7. 15 mil white Isopthalic U.V. resistant gel coat on all surfaces.
8. Tensile strength (ASTM D 638): 14,000 PSI.
9. Flexural strength (ASTM D 790): 27,000 PSI.
10. Flexural modulus (ASTM D 790): 1,000,000 PSI.
11. Barcol hardness (ASTM D 2583): 50
12. Black vinyl edge trim.

Examination:

A. Verify that the shade is of the correct dimensions, fits the equipment to be covered, and is not damaged. Do not proceed with installation until condition deficiencies have been corrected.

Installation:

A. Install products in accordance with engineer's instructions, plans, blueprints, etc.

B. Align the shade in the desired mounting position; horizontally leveling the shade with a bubble level.

C. With a pencil, outline the desired location of the mounting holes on the mounting surface.

D. Drill pilot holes in the outlined positions on the mounting surface with a variable speed drill. Drill to the desired depth of the mounting screws (mounting screws by others). The pilot holes should be drilled smaller the shank of the mounting screw.

E. Position the shade against the mounting surface and install the mounting screws.

F. Install the equipment either on the same mounting screws that support the shade or by screwing additional mounting screws into the shade.

G. For additional installation instructions refer to latest revision of document SHADE-I.

Startup/close out:

A. Clean surfaces in accordance with the manufacturer's instructions.

B. Remove trash and debris and leave the site in a clean condition.

2.2 Panel Front-Mounted Devices.

Digital Panel Indicators. Digital indicators shall be designed for semiflush mounting in a panel. The display shall be a 3-1/2 digit LED or gas-discharge type, with digits at lease 0.5 inch high. The display shall be easily read at a distance of 10 feet in varying control room lighting environments. Operating temperature range shall be 0 to 60° C. Accuracy shall be +/- 0.1 percent. The display shall be scaled in engineering units, with the units engraved on the display face or on the associated nameplate. The display shall have a selectable decimal point and shall provide overrange indication. Digital indicators shall be manufactured by Action Instruments, Electro-Numerics, Newport, or Sycon-Weston.

Selector Switches. Selector switches shall be heavy-duty, oiltight type with gloved-hand or wing level operators. Position legends shall be engraved on the switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 volts ac. Contact configuration shall be as indicated on the drawings or as required for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty. Switches shall be Cutler-Hammer "Type T", General Electric "CR", or Micro Switch "Type PT".

Indicating Lights. Indicating lights shall be heavy-duty, oiltight type, with low voltage

lamps. A built-in transformer shall be used for ac service. Legends shall be engraved on the lens or on a legend faceplate. Lamps shall be easily replaceable from the front of the indicating light. Indicating lights shall be Cutler-Hammer “Type T”, General Electric “CR”, or Micro Switch “Type PT”.

Push Buttons. Push buttons shall be heavy-duty, oiltight type. Legends shall be engraved on the push-button faceplate. Contacts shall be rated 10 amperes continuous at 120 volts ac. Push buttons shall be Cutler-Hammer “Type T”, General Electric “CR”, or Micro Switch “Type PT”.

Panel Interior-Mounted Devices.

Power Supplies. Regulated dc power supplies for instrument loops shall be designed and arranged so that loss of one supply does not affect more than one instrument loop or system. Power supplies shall be suitable for an input voltage variation of +/- 10 percent, and the supply output shall be fused or short-circuit protected. Output voltage regulation shall be as required by the instrumentation equipment supplied. Multiloop or multisystem power supplies will be acceptable if backup power supply units are provided which will automatically supply the load upon failure of the primary supply. The backup supply systems shall be designed so that either the primary or the backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation. The power distribution from multiloop supplies shall be selectively fused so that a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Fuses shall be clearly labeled and shall be located for easy access. Multiloop supply systems shall be oversized for an additional 10 percent future load. Failure of a multiloop supply shall be indicated on the respective instrument panel or enclosure.

Disc filter control systems may be designed so that one power supply feeds all instrument loops common to one individual filter.

Relays. Relays indicated to be provided in panels, enclosures, or systems furnished under this section shall be of the plug-in socket base type with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver-cadmium oxide contacts rated 10 amperes at 120 volts ac. Electronic switching-duty relays shall have gold-plated or gold allow contact suitable for use with low level signals. Relays used for computer input, alarm input, or indicating light service shall have contacts rated at least 3 amperes. Time-delay relays shall have dials or switch settings engraved in seconds and shall have timing repeatability of +/- 2.0 percent of setting. Latching and special purpose relays shall be as required for the specific application. Relays shall be Eagle Signal “Series 22, 80" IDEC “Series RR”; Potter & Brumfield “Series KRP, CB”; or Struthers-Dunn “Series A3, A4".

Universal Times to record hours of operation on each of the specified units shall be

furnished and installed inside the specified control panel.

2.3 PANEL WIRING GUIDELINES: Discrete and analog wiring shall be arranged for separate conduit entry and terminations. No top panel penetration will be tolerated. Wiring shall be consistent with electrical specification 16304.

2.4 PANEL HEATING AND COOLING: Control panels shall be furnished with heaters to mitigate condensation. Panels shall be designed for surface area cooling or ventilation or AC systems to maintain maximum temperatures.

PART 3- EXECUTION

PANEL FABRICATION: All panels furnished and installed under this section shall conform to the general fabrication requirements unless otherwise specified.

METERING & CONTROL SYSTEMS: Principal components of the metering and control systems are indicated on the piping and instrument diagram drawings and on the instrument device schedule drawings.

GENERAL INSTALLATION REQUIREMENTS:

The instrumentation equipment shall be installed by the Contractor or his subcontractors in accordance with the manufacturers' instructions. The services of the system supplier's technical representative shall be provided as necessary to calibrate, test, and advise others of procedures for adjustment and operation in accordance with the requirements of the quality control section.

Field Wiring. Field wiring materials and installation shall conform to the requirements of the electrical section and the requirement of flow proportional sampling.

Field Piping. Field piping materials and installation shall conform to the requirements of the miscellaneous piping section.

Field-Mounted Instruments. Instruments shall be mounted so that they may be easily read and serviced, and all appurtenant devices are easily operated. Installation details for some instruments are indicated on the drawings. Unless otherwise indicated on the drawings, instruments which include local indicators shall be mounted approximately 5 feet above the floor and shall be oriented for ease of viewing.

Transmitters shall be mounted on corrosion-resistant pipe supports suitable for floor, wall, or bracket mounting.

Field Calibration. A technical representative of the system supplier shall calibrate each instrument and shall provide a written calibration report for each instrument, indicating

the results and final tuning adjustment settings. The adjustments of each calibrated instrument shall be sealed or marked, insofar as possible, to discourage tampering. Instruments shall be calibrated before checkout of the operation of the system. A typical instrument calibration report form is included at the end of this section.

Systems Check. A technical representative of the system supplier shall participate in the checkout of metering and control systems. If interrelated devices furnished by other suppliers, such as valve actuators, motor controls, chemical feeders, or primary measuring devices, do not perform properly when place in service, the technical representative shall use suitable test equipment to introduce simulated signals to verify or measure signals from such devices as required to locate the source of trouble or malfunction. A written report stating the results of such tests shall be furnished, if requested by the Engineer, to assign responsibility for corrective measures.

Installation Test Equipment. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by the Contractor for the duration of the testing work. Unless specified otherwise, test equipment will remain the property of the Contractor or the system supplier.

CUSTOMER TRAINING:

The coordinating supplier shall provide a qualified representative at the jobsite to train the Owner's personnel in operating, programming, flow proportional setting, and maintenance of the equipment. The training session shall include a technical explanation of the equipment and an actual hands-on demonstration. The training session shall consist of five consecutive 8-hour Owner working days, and the schedule shall be arranged and coordinated with the Owner.

MANUFACTURER'S SUBMITTALS:

Complete fabrication, assembly, and installation drawings; wiring and schematic diagrams; and details, specifications, and data covering the materials used and the parts, devices, and accessories forming a part of the equipment furnished shall be submitted in accordance with the submittals section. Submittal data shall be grouped and submitted in three separate stages. The submittal for each stage shall be substantially complete. Individual drawings and data sheets submitted at random intervals will not be accepted for review. Instrument tag numbers indicated on the contract drawings shall be referenced where applicable. Submittal data for multifunctional instruments shall include complete descriptions of the intended functions and configurations of the instruments.

First Stage Submittal: The first stage submittal shall include the following items:

a. Product catalog cut sheets clearly marked to show the model number, optional features, and intended service of the device.

b. A detailed list of any exceptions, functional differences, or discrepancies between the supplier's proposed system and the contract requirements.

Second Stage Submittal: The second stage submittal shall include the following items:

a. Complete panel fabrication drawings and details of panel wiring, piping, and painting. Panel and subpanel drawings shall include overall dimensions, metal thickness, door swing, mounting details, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and control devices.

b. System wiring and installation drawings for all interconnecting wiring between components of the systems furnished and for all interconnecting wiring between the related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections.

   If panel terminal designations, interdevice connections, device features and options, or other features are modified as a result of the fabrication process or factory testing, revised drawings shall be resubmitted.

At the supplier's option, and for projects with very few fabrication drawings, the first stage and second stage submittals may be combined.

Third Stage Submittal. Complete system documentation, in the form of operation and maintenance manuals, shall be provided. Manuals shall include complete product instruction books for each item of equipment furnished.

Where instruction booklets cover more than one specific model or range of instrument, product data sheets shall be included which indicate the instrument model number, calibrated range, and all other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings shall be included with the manuals. Manufacturer shall provide standard Operations and Maintenance (O&M) manual and Standard Operations Procedures (SOP's) for normal and emergency modes of operations to the Owner upon project completion.

PART 4- PAYMENT

Payment for all the instrumentation services shall be covered under the lump sum contract amount.

END OF SECTION 11600

SECTION 16000 - BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Basic Electrical Requirements specifically applicable to this Division. All requirements in Division 1 - General Requirements apply to this division.

1.2 SUMMARY OF WORK

A. General: The intent of this contract is to provide necessary services for the electrical modifications at the Existing Wastewater Treatment Plant, in Mount Carmel, Tennessee. The work includes replacing/adding new electrical wiring for new mixers, screen, conveyor, heat trace controls, filtration unit, heated enclosure, and new panelboards in the electrical/control building.

B. General Summary of Work: The work of the Contract includes, but not limited to the following:

1. The Treatment Plant will remain in operation during construction. All shut-downs shall be scheduled with operator.
2. Provide new 277/480V-3PH-800A electric service to serve new motor loads and backfeed the existing 277/480V-3PH-400A service gear.
3. Underground raceways from building to headworks, anoxic basins, filtration unit, and where else noted on the plans.
4. Installation of new breakers in existing panels, disconnect switches and starters, lighting, receptacles, and panelboards as noted.
5. Grounding systems and grounding conductors.
6. Raceways, conductors, boxes, fittings, and accessories.
7. Wiring to control panels, VFDs, and motors.
8. Control wiring: Sensors and related items.
9. Installation of new lighting in the yard piping.
10. Removal of existing electrical and related items at completion.
11. Incidental items required to provide a complete and useable project.

12. Rewire and reconnect existing items.

C. Definition: Definition and terms used in this Division are essential to the Designer and the Contractor's relationship. Therefore, the following references are given:

1. NEC – 2017.

2. IEEE Standard Dictionary of Electrical & Electronic Terms.

3. Other definition related to codes and standards.

1.3 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code 2014.

B. IEEE - Standard Electrical and Electronic Terms.

1.4 SUBMITTALS

A. Submit under provisions of specifications.

B. Proposed Products List: Include Products specified in the following:

1. Raceway and conductors
2. Service equipment and disconnect switches
3. Panelboards and breakers
4. Surge Protective Device (SPD)
5. Transformers
6. Fixtures, devices, and lamps
7. Mechanical screen, conveyor and new control panels
8. Heat Trace Package and Controls,
9. Anoxic Mixers
10. Filtration Unit and Controls
11. Heated enclosure and controls

C. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittals.

D. Mark dimensions and values in units to match those specified.

1.5 REGULATORY REQUIREMENTS

A. Conform to Standard Building Code for electrical installations.

B. Electrical: Conform to NFPA 70 – 2017.

C. General: Conform to Tennessee Electrical Code and local electric system.

D. Obtain permits, and request inspections from authority having jurisdiction.

1.6 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Designer before proceeding.

1.7 CONTRACTOR'S USE OF PREMISES

A. General: The Contractor shall limit his use of the premises to the work indicated so as to allow for Owner's occupancy.

1. Use of the Site: Confine operations at the site to the areas permitted under the Contract. Portions of the site beyond areas on which work is indicated are not to be disturbed. Conform to site rules and regulations affecting the work while engaged in project construction.

2. Do not unreasonably encumber the site with materials or equipment. Confine stockpiling of materials and location of storage sheds to the job site. If off site storage is necessary, the contractor shall obtain and pay for such storage.

B. Rough In:

1. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

C. Electrical Installations:

1. Coordinate electrical equipment and materials installation with other components.

2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in other components to allow for electrical installations.

4. Coordinate the installation of required supporting devices and sleeves to

be set in poured in place concrete and other structural components, as they are constructed.

5. Coordinate the cutting and patching of components to accommodate the installation of electrical equipment and materials.

6. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.

D. Cutting and Patching:

1. This Article specifies the cutting and patching of electrical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.

2. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.

3. Perform cutting, fitting, and patching of electrical equipment and materials required to:

a. Uncover Work to provide for installation of ill-timed Work;

b. Remove and replace defective Work;

c. Remove and replace Work not conforming to requirements of the Contract Documents;

d. Remove samples of installed Work as specified for testing;

e. Install equipment and materials in existing structures;

f. Upon written instructions from the Designer uncover and restore work to provide for observation of concealed Work.

4. Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.

E. Construction Record Documents:

1. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned for column

lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices.

2. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

F. Codes, Permits, & Fees:

1. The Contractor shall give all necessary notices, including electric and telephone utilities, obtain all permits, and pay all government taxes, fees, and other costs, including utility connection with his work; file all necessary plans, prepare all documents, and obtain all necessary approvals of all governmental departments having jurisdiction; obtain all required certificates of inspection for his work and deliver same to the Designer before request for acceptance and final payment for the work.

   The work shall be inspected by the Tennessee State Electrical Inspector.

2. Work and materials shall conform to the latest rules of the National Board of Fire Underwriters' Code, Regulations of the State Fire Marshal, and with applicable local codes and with all prevailing rules and regulations pertaining to adequate protection and/or guarding of any moving parts, or otherwise hazardous conditions. Nothing in these Specifications shall be construed to permit work not conforming to the most stringent of applicable codes.

3. The National Electrical Code, the local electric code, and the electrical requirements as established by the State and Local Fire Marshal, and rules and regulations of the power company serving the project, are hereby made part of this Specification. Should any changes be necessary in the Drawings or Specifications to make the work comply with these requirements, the Contractor shall notify the Designer before proceeding with the work.

4. Compile and assemble the warranties specified in Section 16, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

PART 2- PAYMENT

All electrical work and services shall be included under the lump sum contract amount.

END OF SECTION 16000

SECTION 16053- ELECTRICAL IDENTIFICATION

PART 1 GENERAL

A. WORK INCLUDED

1. Nameplates and tape labels.

2. Wire and cable markers.

3. Conduit color coding.

PART 2 PRODUCTS

A. MATERIALS

1. Nameplates: Engraved three-layer laminated plastic, black letters on a white background.

2. Pre-printed plastic tape labels.

3. Wire and Cable Markers: Cloth markers, split sleeve or tubing type.

PART 3 EXECUTION

A. INSTALLATION

1. Degrease and clean surfaces to receive nameplates and tape labels.

2. Install nameplates and tape labels parallel to equipment lines.

3. Secure nameplates to equipment fronts using screws, rivets, or adhesive. Secure nameplate to inside face of recessed panelboard doors in finished locations.

4. Embossed tape will not be permitted for any application.

B. WIRE IDENTIFICATION

1. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.

C. NAMEPLATE ENGRAVING SCHEDULE

1. Provide nameplates to identify all electrical distribution and control equipment, and loads served. Letter Height: 1/4 inch (6 mm) for individual switches and loads served, 1/4 inch (6 mm) for distribution and control equipment identification.

2. Provide nameplates of minimum letter height as scheduled below.

3. Panelboards: 1/4 inch (6 mm); identify equipment designation. 1/4 inch (6 mm); identify voltage rating and source.

4. Individual Circuit Breakers in Panelboards: 1/8 inch (3 mm); identify circuit and load served, including location.

5. Individual Circuit Breakers, Enclosed Switches, and Motor Starters: 1/8 inch (3 mm); identify load served.

6. Transformers: 1/4 inch (6 mm); identify equipment designation. 1/8 inch (3 mm); identify primary and secondary voltages, primary source, and secondary load and location.

D. CONDUIT COLOR CODING SCHEDULE

1. Use colored tape to identifying conduit by system.

2. 480 Volt, Three Phase System: Blue.

3. 208 Volt, Single and Three Phase System: Yellow.

4. Telephone System: Green.

Wiring Color Code:

120/208 Volt	277/480 Volt	
Black	Orange	Phase A
Red	Yellow	Phase B
Blue	Brown	Phase C
White	White	Neutral (Grounded Conductor)
Green	Green	Equipment Ground (Grounding Conductor)

PART 4- PAYMENT

All electrical work shall be included under the lump sum contract amount.

END OF SECTION 16053

SECTION 16150- ELECTRICAL DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

1. Section Includes:
    1. Removal of existing electrical equipment, wiring, and conduit in areas to be upgraded; removal of designated construction; dismantling, cutting and alterations for completion of the Work.
    2. Disposal of materials.
    3. Storage of removed materials.
    4. Identification of utilities.
    5. Salvaged items.
    6. Protection of items to remain as indicated on Drawings.
    7. Relocate existing equipment to accommodate construction.

1.2 SEQUENCING

1. Requirements for sequencing.

2. Sequence and schedule work as indicated on Drawings:

1.3 COORDINATION

1. Administrative Requirements: Requirements for coordination.

2. Conduct demolition to minimize interference with adjacent building areas.

3. Coordinate demolition work with other trades.

4. Coordinate and sequence demolition so as not to cause shutdown of operation of surrounding areas.

5. Shut-down Periods:
    1. Arrange shut down of existing panels a minimum of 72 hours in advance with Owner. Do not shut down any utility without prior written approval.
    2. Keep shut-down period to minimum or use intermittent period as directed.
    3. Maintain life-safety systems in full operation in occupied facilities.

6. Identify salvage items in cooperation with Owner.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 EXAMINATION

1. Section 01300 - Administrative Requirements: Verification of existing conditions before starting work.

2. Verify wiring and equipment indicated to be demolished serve only abandoned facilities.

3. Verify termination points for demolished services.

3.2 PREPARATION

1. Erect, and maintain temporary safeguards, including warning signs and lights, barricades, and similar measures, for protection of the public, Owner, Contractor’s employees, and existing improvements to remain.

2. Arrange for temporary egress signage and emergency lighting where necessary.

3.3 DEMOLITION

1. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

2. Remove conduit, wire, boxes, and fastening devices back to serving panel.

3. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

4. Reconnect equipment being disturbed by renovation work and required for continued service.

5. Disconnect or shut off service to areas where electrical work is to be removed. Remove electrical fixtures, equipment, and related switches, outlets, conduit and wiring which are not part of final project.

6. Install temporary wiring and connections to maintain existing systems in service during construction.

7. Perform work on energized equipment or circuits with experienced and trained personnel.

8. Remove, relocate, and extend existing installations to accommodate new construction.

9. Repair adjacent construction and finishes damaged during demolition and extension work.

10. Remove exposed abandoned grounding and bonding components, fasteners and supports, and electrical identification components. Cut embedded support elements flush with walls and floors.

11. Clean and repair existing equipment to remain or to be reinstalled.

12. Protect and retain power to existing active equipment remaining.

13. Cap abandoned empty conduit at both ends.

14 If circuitry within the area of demolition serves equipment located outside the boundaries of the demolition, the continuity of the circuits shall be maintained as required to keep the equipment operational. Provide back feed to panel as necessary.

3.4 EXISTING PANELBOARDS

1. Ring out circuits in existing panel affected by the Work. Where additional circuits are needed, reuse circuits available for reuse. Install new breakers where necessary.

2. Tag unused circuits as spare.

3. Where existing circuits are indicated to be reused, use sensing measuring devices to verify circuits feeding Project area or are not in use.

4. Remove existing wire no longer in use from panel to equipment.

5. Provide new updated directories where more than three circuits have been modified or rewired.

3.5 SALVAGE ITEMS

1. Remove and protect items to be salvaged and turn over to Owner for right of first refusal. Any materials rejected by owner shall be removed from the premises by contractor.

2. Items of salvageable value may be removed as work progresses. Transport salvaged items from site as they are removed.

3.6 REUSABLE ELECTRICAL EQUIPMENT

1. Carefully remove equipment, materials, or fixtures which are to be reused.

2. Disconnect, remove, or relocate existing electrical material and equipment interfering with new installation.

3. Relocate existing lighting fixtures as indicated on Drawings. Clean fixtures and re-lamp. Test fixture to see if it is in good working condition before installation at new location.

4. The contractor may reuse existing concealed conduit and recessed device boxes where appropriately located. Verify the equipment is in satisfactory condition, and properly supported. Existing devices, wiring and faceplates shall not be re-used.

3.7 CLEANING

1. Section 01700 - Execution Requirements: Requirements for cleaning.

2. Remove demolished materials as work progresses. Legally dispose.

3. Keep workplace neat.

3.8 PROTECTION OF FINISHED WORK

1. Section 01700 - Execution Requirements: Requirements for protecting finished Work.

2. Do not permit traffic over unprotected floor surface.

PART 4- PAYMENT

All electrical work shall be paid under the lump sum contract amount.

END OF SECTION 16150

SECTION 16220 - TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of transformer work is indicated by drawings and schedules.

B. Types of transformers specified in this section include the following:

1. Dry-type Transformers.

1.2 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to installation and construction of electrical power/distribution transformers.

B. NEMA Compliance: Comply with applicable portions of NEMA Std Pub Nos. TR 1 and TR 27 pertaining to power/distribution transformers.

C. ANSI Compliance: Comply with applicable ANSI standards pertaining to power/ distribution transformers.

D. ANSI/IEEE Compliance: Comply with applicable ANSI/IEEE standards pertaining to power/distribution transformers.

E. ANSI/NEMA Compliance: Comply with NEMA Std ST 20; "Dry Type Transformers for General Applications".

F. ANSI/UL Compliance: Comply with applicable portions of ANSI/UL 506; "Safety Standard for Specialty Transformers".

G. UL Labels: Provide distribution transformers which have been UL-listed and labelled.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data including rated KVA, frequency, primary and secondary voltages, percent taps, polarity, impedance, and certification of transformer performance efficiency at indicated loads,

percentage regulation at 100% and 80% power factor, no-load and full-load losses in watts, % impedance at 75 degrees C hot-spot and average temperature rise above 40 degrees C ambient, sound level in decibels, and standard published data.

B. Shop Drawings: Submit manufacturer's drawings indicating above data, dimensions, and weight loadings for transformer installations, showing layout, mountings and supports, spatial relationship to associated equipment, and transformer connections to electrical equipment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Manufacturer: Subject to compliance with requirements, provide products of one of the following for each type of transformer: (Note that the transformer manufacturer shall be the same as the manufacturer for all other electrical gear on the project.)

Cutler-Hammer.

Siemen.

General Electric Company.

Square D Company.

2.2 POWER/DISTRIBUTION TRANSFORMERS

A. General: Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

B. Dry-Type Distribution Transformers (below 45 KVA): Provide factory-assembled, general-purpose, ventilated, dry-type distribution transformers where shown; of sizes, characteristics, and rated capacities indicated; 3-phase, 60-hertz, 5.75%

C. impedance insulation per NEMA ST20; with 480-volt delta-connected primaries; and 208/120 volt, 4 wires wye-connected secondaries with grounded neutral. Provide primary windings with 6 taps; two 2-1/2% increments above full-rated voltage and four 2-1/2% increments below full-rated voltage for de-energized tap-changing operation. Insulate with Class 220 degrees C insulation. Rate transformer for continuous operation at rated KVA; limit transformer surface temperature rise to maximum of 115 degrees C. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector. Provide terminal board with clamp type connectors. Limit terminal compartment temperature to 75 degrees C when transformer is operating continuously at rated load with ambient temperature of 40 degrees C. Provide wiring connections suitable for copper or aluminum wiring. Integrally mount vibration isolation supports between core and coil assembly and transformer enclosure; electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap. Do not exceed maximum sound-level rating of 45 db as determined in accordance with ANSI/NEMA standards. Provide transformers with fully-enclosed weather-resistant steel enclosures and lifting lugs. Apply manufacturer's standard light grey outdoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for floor mounting. Install nonventilated NEMA 4XSS transformers as indicated on drawings.

D. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

E. Transformers shall be compliant with NEMA TP-1 energy efficiency requirements per EPACT 2005/CFR 10 Part 431.

PART 3 - EXECUTION

3.1 INSTALLATION OF TRANSFORMERS

A. Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.

C. Install units on vibration mounts; comply with manufacturer's indicated installation method if any.

D. Connect transformer units to electrical wiring system; comply with requirements of other Electrical Work sections.

E. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

F. Examine walls and floors for suitable mounting conditions where transformers will be installed.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Install floor-mounting transformers level on concrete bases. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directors than supported unit and 4 inches (100 mm) high.

1. Anchor transformers to concrete bases according to manufacturer's written instructions.

3.3 GROUNDING

A. Provide equipment grounding connections, sufficiently tight to assure permanent and effective ground. Provide a separately derived grounding point for each transformer. Extend grounding conductor to an earth electrode and building steel. Where available, connect to a cold water main.

3.4 TESTING

A. Upon completion of installation of transformers, energize primary circuit at rated voltage and frequency from normal power source and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise,

remove and replace with new units and proceed with retesting. Test voltage and connect tap setting for an acceptable no load voltage level.

PART 4- PAYMENT

All electrical work shall be paid under the lump sum contract amount.

END OF SECTION 16220

SECTION 262413 – SWITCHBOARDS

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK:

A. Provide service and distribution switchboards as indicated on the Drawings.

B. Refer to other Electrical work sections for fuses, cable/wire, connectors, electrical raceway, and ground fault protection work required in conjunction with switchboard; not work of this section.

1.02 QUALITY ASSURANCE

A. Manufacturer: For each material type required for the work of this section, provide primary materials which are the product of one manufacturer. Provide secondary or accessory materials that are acceptable to the manufacturers of the primary materials.

B. Performance Requirements: Provide switchboards manufactured in accordance with Article 384 of the National Electrical Code and applicable portions of the NEMA PB2, U.L. 891 and NFPA 70, the National Electrical Code.

1.03 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage from weather, excessive temperatures and construction operations.

B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250 W per section) to prevent condensation.

D. Handle switchboards according to NEMA PB 2.1 AND NECA 400.

1.04 COORDINATION

A. Coordinate layout and installation of switchboards and components with

other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-volt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of switchboard):
Square D Company
Cutler-Hammer

2.02 SWITCHBOARDS:

A. Switchboard shall be of the modular type construction, constructed in accordance with the latest NEMA PB-2 and U.L. 891 standards, with the required number of vertical sections bolted together to form one metal enclosed rigid switchboard. The sides, top and rear shall be covered with removable screw-on code gauge steel plates. Switchboard shall include all protective devices and equipment as listed on drawings with necessary interconnections, instrumentation and control wiring. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide switchboards for 208Y/120-Volt or 480Y/277-Volt service as determined by the use. Wet location panelboards shall be NEMA 3R enclosures. If indicated on plans, switchboard shall be suitable for use as service equipment and be labeled in accordance with U.L. requirements.

B. Bus Requirements: The bus shall be full length silver-plated copper and of sufficient size to limit the temperature rise to 65EC, based on U.L. tests. The bus shall be braced as indicated and supported to withstand mechanical forces exerted during short circuit conditions when directly connected to a power source having the indicated available short circuit current. Refer to plans for available short circuit current. Provide a full capacity neutral where a neutral is indicated on the drawings. The through bus on the end section shall be extended and pre-drilled to allow the addition of future sections with standard splice plates. Through bus shall be non-tapered. Ground bus and grounding conductor lug shall be furnished. Ground bus shall extend the entire length of the switchboard and shall be firmly secured to each vertical section.

C. Incoming Service:

1. Underground Service: To isolate incoming underground service conductors, an underground cable pull or auxiliary section shall be used. This section shall be of the bussed type and shall be sealable per local utility requirements. Screw-type mechanical lugs to terminate and copper cable shall be furnished as detailed on the plans.
2. Overhead Service: Cable entry: Screw-type mechanical lugs to terminate and copper cable shall be furnished as detailed on the plans. Where necessary provide top cable pull box that shall be sealable per local utility requirements.
3. Service Section: The service section shall be designed for the system parameters indicated, and shall have user metering as indicated, and shall have a main protective device indicated.

D. Distribution Sections:

1. Switchboard Type: Panel-Mounted, Front Accessible
a. Individual sections shall be front accessible, not less than 20” deep, and the rear of all sections shall align. Incoming line termination, main device connection and all bolts used to join current-carrying parts shall be installed so as to permit servicing from the front only so that no rear access is required. The branch devices shall be front removable and panel mounted with line and load side connections front accessible.

E. Switchboard Accessories:

1. Metering Equipment: Provide a multi-function, high accuracy digital power metering instrumentation module equipped with an LCD display. The power metering module shall provide simultaneous measurements for current, voltage, and power parameters. Power meter shall be equipped with a ethernet communications port for connection to customer's SCADA network. Protocol shall be Allen Bardley Ethernet IP
2. Ground Fault Protection: Provide as indicated on plans and in Section 16450.
3. Finish: The complete switchboard shall be phosphatized and finished with light gray. ANSI 61 paint.
4. Each switchboard section shall have a nameplate permanently affixed to it, listing the following information: Name of manufacturer, system voltage, ampacity, type, manufacturer's shop order number and date.
5. Each section of switchboard shall bear a U.L. listing mark, where qualified, and a short circuit rating label.
6. Front, side, rear and top of each switchboard section will have a

DANGER label in accordance with NEMA Standard PB-2.
7. Spare heaters.
8. Hinged.
9. Future Devices.

F. Branch Protective Devices

1. Molded-Case Circuit Breaker: NEMA AB3. With interrupting capacity to meet available fault currents. For breakers 200A and above.
a. Electronic tip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:

(1) Instantaneous Trip
(2) Long-and short-time pickup levels
(3) Long- and short-time adjustments
(4) Ground-fault pickup level, time delay, and I^2t response

2. Molded-Case Circuit Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles. For breakers less than 200A.

a. lugs: Mechanical style, suitable for number, size trip ratings, and conductor material.
b. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

3. Main Protection Devices: Enclosed, Insulated-Case Circuit Breaker: Fully rated, encased-power circuit breaker with interrupting capacity rating to meet available fault current.

a. Fixed circuit-breaker mounting.
b. Two-step, stored-energy closing.

4. Microprocessor-based trip units with interchangeable rating plug, LED trip indicators, and the following field-adjustable settings:

a. Instantaneous trip
b. Long- and short-time pickup levels
c. Long- and short-time adjustments with I^2t response
d. Ground-fault pickup level, time delay, and I^2t response

5. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

a. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
b. Space-Heater Power Source: Transformer, factory install in switchboard.

6. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

7. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.03 TRANSIENT VOLTAGE SUPPRESSION DEVICES

A. IEEE C62.41, integrally mounted, plug-in-style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.

B. Minimum single-impulse current rating shall be as follows:

1. Line to Neutral: 65,000A.
2. Line to Ground: 65,000A.
3. Neutral to Ground: 50,000A.

C. Protection modes shall be as follows:

1. Line to neutral
2. Line to ground
3. Neutral to ground

D. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.

E. Maximum Category C combination wave clamping voltage shall not exceed 1000 V, line to neutral and line to ground on 277/480 V systems.

F. Maximum UL 1449 clamping levels shall not exceed 800 V, line to neutral and line to ground on 277/480 V systems.

G. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.

H. Accessories:

1. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position

on failure of any surge diversion module.
2. Audible alarm activated on failure of any surge diversion module.
3. Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125 V.

PART 3 – EXECUTION

3.01 INSTALLATION OF SWITCHBOARDS:

A. General: Install switchboards where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
B. Coordinate installation of switchboards with cable and raceway installation work.
C. Provide electrical connections within enclosures.

END OF SECTION 16230

SECTION 16245 - MOTOR CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is an Electrical Work Basic Materials and Methods section and is part of Electrical Work section making reference to motor starters specified herein.

C. Refer to other sections of these specifications for motor starter equipment furnished under other sections work and installed under Electrical Work.

1.2 DESCRIPTION OF WORK:

A. Extent of motor starter work is indicated by drawings and schedules.

B. Types of motor starters in this section include the following:

1. Soft start motor controllers

2. Duplex pump control

3. Manual

C. Refer to other sections of these specifications.

1.3 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of motor starters, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer: Qualified with at least 3 years of successful installation experience on projects with electrical work similar to that required for this project.

C. NEC Compliance: Comply with NEC as applicable to wiring methods, construction, and installation of motor starters.

D. UL Compliance and Labeling: Comply with applicable requirements of UL 508, "Electric Industrial Control Equipment", pertaining to electrical motor starters. Provide units which have been UL-listed and labeled.

E. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to motor controllers/starters and enclosures.

1.4 SUBMITTALS:

A. Product Data: For each type of controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each motor-control starter.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details

b. Nameplate legends

c. Short-circuit current ratings of buses and installed units

d. Vertical and horizontal bus capacities

e. UL listing for series rating of over-current protective devices in combination controllers

f. Features, characteristics, ratings, and factory settings of each motor-control center unit

2. Wiring Diagrams: Power, signal, and control wiring for class and type of motor-control center. Differentiate between manufacturer-installed and field-installed wiring. Provide schematic wiring diagram for each type of controller.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around motor-control starters where pipe and ducts are prohibited. Show motor-control starter layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Manufacturer Seismic Qualification Certification: Submit certification that motor-control centers, accessories, and components will withstand seismic forces as defined below:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Manufacturer's field service report

F. Maintenance Data: For motor-control starters, all installed devices, and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:

1. Routine maintenance requirements for motor-control centers and all installed components

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices

G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

I. Maintenance Stock, Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every 10 installed units, but not less than 5 units of each.

1.5 COORDINATION

A. Coordinate layout and installation of motor-control starters with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

D. Coordinate features of motor-control starters, installed units, and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each motor-control starter, each controller, and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Manufacturer: Subject to compliance with requirements, provide products of one of the following (for each type and rating of motor starter):

a. Square D Co.

b. Allen Bradley

2.2 MOTOR STARTERS:

A. General: Except as otherwise indicated, provide motor starters and ancillary components; which comply with manufacturer's standard materials, design, and construction in accordance with published product information, and as required for complete installation. Where more than one type of equipment meets indicated requirements, selection is Installer's option.

B. Combination Starters: Provide full-voltage alternating-current combination starters, consisting of starters and disconnect switches mounted in common enclosures; of types, sizes, ratings, and NEMA sizes indicated. Equip starters with block type manual reset overload relays with spare auxiliary contacts and with non-fusible disconnect switches. Provide operating handle for disconnect switch mechanism providing indication and control of switch position with enclosure door open or closed; and capable of being locked in OFF position. Construct and mount starters and disconnect switches in single NEMA Type enclosure required by the application.

C. Solid state, soft start starters shall be suitable and applicable to the motor and load controlled: Pump motor starters shall have the following basic features: Soft start and soft stop with adjustable ramping feature to bring the pump motor and pump up to speed and down to stop slowly to avoid hydraulic shock; Shorting contactors; Isolation contactors; auxiliary contacts to monitor status; Ethernet communications card for PLC communication. Protocol shall be Allen Bradley Ethernet/IP. Starters shall have the standard features of Square D Co. Altistart devices in addition to the features above described and provide all required motor protection requirements.

D. AC Fractional HP Manual Starters: Provide manual single-phase fractional HP motor starters, of types, ratings and electrical characteristics indicated; equip with thermal overload relay with field adjustment capability of plus or minus 10% variation of nominal overload heater rating, for protection of 120 VAC motors of 1/2 HP and less. Provide starters with quick-make, quick-break trip free toggle mechanisms, mount starter in NEMA Type enclosure required by application.

2.3 MAGNETIC MOTOR CONTROLLERS

A. Description: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated.

B. Combination Controller: Factory-assembled combination controller and disconnect switch.

1. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor circuit protector with field-adjustable, short-circuit trip coordinated with motor lock-rotor amperes.

C. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

D. Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors. Square D Altistart with Ethernet Communications card. Protocol shall be Allen Bradley Ethernet/IP.

1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.

2. Surge suppressor in solid-state power circuits providing 3phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.

3. LED indicators showing motor and control status, including the following conditions:

a. Control power available

b. Controller on

c. Overload trip

d. Loss of phase

e. Shorted silicon-controlled rectifier.

4. Automatic voltage-reduction controls to reduce voltage when motor is running at light load.

5. Motor running contactor operating automatically when full voltage is applied to motor.

E. Circuit Breakers: Starter and/or feeder breakers to be of the molded case type. Breakers to have minimum interrupting capacity as shown on the motor control schedule.

F. All starters to have reset buttons, ON and OFF push-button selector switches, to be mounted in covers. All necessary auxiliary interlocks as required and shown on elementary diagrams to be furnished; and, in addition, on spare auxiliary interlock to be furnished with each starter.

2.4 CONTROL AND LOGIC:

A. The motor control shall contain space in separate compartments for all required timing relay duplex pump controls, control logic and related function as required to result in a finished and working project.

B. Provide a single central control power transformer with primary and secondary overcurrent protection. Provide a fused 120-volt control power circuit for each separate starter device.

C. Control devices shall be furnished and installed as specified throughout all sections of these specifications and the total package drawings. Provide HAND-OFF-AUTO Selector switch for all automatic control systems. Provide start stop push button for manual systems. Provide NEMA 4XSS hands-off-auto lock out stations and start/stop stations for all remote stations located on the drawings.

D. Furnish 1 set of NO and 1 set of NC auxiliary contacts for each starter in addition to control contacts required for system operation. F. Provide panel mounted running light for all systems.

G. Provide interface and redundant control at remote monitor station as required by other sections of the project specifications.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR STARTERS:

A. Install motor starters as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate with other work including motor and electrical wiring/cabling work, as necessary to interface installation of motor starters with other work.

C. Install fuses in fusible disconnects, if any.

D. Comply with mounting and anchoring requirements specified by supplier.

3.2 ADJUST AND CLEAN:

A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finish.

C. Set field-adjustable switches and circuit breakers trip ranges.

3.3 FIELD QUALITY CONTROL:

A. Subsequent to wire/cable hook-up, energize motor starters and demonstrate functioning of equipment in accordance with requirements; where necessary correct malfunctioning units.

3.4 GENERAL:

A. All units to be identified with permanent type engraved Bakelite nameplates on face of units showing motor or equipment being served. Bakelite nameplates to be fastened with two round head screws. All terminal blocks, relays, starters, timers, etc., to be identified internally with designation as shown on drawings.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that motor-control starters and components are installed and connected according to the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-control starters and variable-frequency drives.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

2. Review data in maintenance manuals. Refer to Division 1 Section "Closeout Procedures."

3. Review data maintenance manuals. Refer to Division 1 "Operation and Maintenance Data."

4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

PART 4- PAYMENT

All electrical work shall be paid under the lump sum contract amount.

END OF SECTION 16245

SECTION 16255 - PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of panelboard, load-center, and enclosure work, including cabinets and cutout boxes, is indicated by drawings and schedules.

B. Types of panelboards and enclosures in this section include the following:

1. Main service panelboard.

2. Lighting and power panelboards.

C. Refer to other Electrical work sections for cable/wire, connectors and electrical raceway work required in conjunction with panelboards and enclosures; not work of this section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of panelboard and enclosure):

1. General Electric Company

2. Siemens

3. Square D Company

4. Cutler-Hammer

2.2 PANELBOARDS

A. General: Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information; equip with number of unit panelboard devices as

required for complete installation. Where more than one type of component meets indicated requirements, selection is Installer's option. Where types, sizes, or ratings are not indicated, comply with NEC, UL and established industry standards for applications indicated.

B. Main Service Panelboard: Provide dead-front safety type power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, types and with arrangement shown; with anti-turn solderless pressure type main lug connectors approved for copper conductors. Construct unit for connecting feeder at top or bottom of panel to suit application. Equip with copper bus bars, and full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide molded-case main and branch circuit breaker types for each circuit, with toggle handles that indicate when tripped. Where multiple-pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Provide a bare uninsulated grounding bar suitable for bolting to enclosure. Provide panelboards fabricated by same manufacturer as enclosures, and which mate properly with enclosures. Panel shall be service entrance rated, with fault current withstand value as indicated on the drawings and coordinated with the local power company.

C. Lighting and Power Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, door in door construction, types and arrangement shown; with anti-turn solderless pressure type lug connectors approved for copper conductors; construct unit for connecting feeders at top or bottom of panel as arrangement requires; equip with copper bus bars, full-sized neutral bar, with bolt-in type heavy-duty molded case circuit breakers; provide suitable lugs on neutral bus for each outgoing feeder required; provide bare uninsulated grounding bar suitable for bolting to enclosure; and provide panelboards fabricated by same manufacturer as enclosures, and which mate properly with enclosure. Provide panels for 208Y/120-Volt or 480Y/277-Volt service as determined for the use. Provide NEMA 4XSS panelboards as indicated on drawings.

D. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code gauge, minimum 16-gauge thickness. Construct with multiple

knockouts and wiring gutters. Provide fronts with adjustable indicating trim clamps, and doors with flush locks and keys, door in door construction, all panelboard enclosures keyed alike, with concealed door hinges and door swings as indicated. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor. Design enclosure for recessed or surface mounting as Provide enclosures fabricated by same manufacturer as panelboards, and which mate properly with panelboards to be enclosed. Provide panels for 208Y/120-Volt or 480Y/277-Volt service as determined by the use. Provide NEMA 4XSS panelboards as indicated on drawings.

E. Panelboard Accessories: Provide panelboard accessories and devices including, but not necessarily limited to, cartridge and plug time-delay type fuses, circuit breakers, ground-fault protection units, etc., as recommended by panelboard manufacturer for ratings and applications indicated. Provide extra gutter space; split-bus; contactor space; and circuit breaker arrangement to accommodate the energy management system described in other specifications. Provide suitable enclosure space to accommodate time clock; relays; contactors and control items as shown on the drawings. The separate space shall be under a separate door located at the top of the panel with locking provisions.

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELBOARDS

A. General: Install panelboards and enclosures where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate installation of panelboards and enclosures with cable and raceway installation work.

C. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.

D. Provide 4” concrete housekeeping pad bases for all floor-mounted panelboard enclosures, typically rated 800A and higher.

E. Provide electrical connections within enclosures.

F. Fill out panelboard's circuit directory card upon completion of installation work. Directory shall be type written.

PART 4- PAYMENT

All electrical work shall be paid under the lump sum contract amount.

END OF SECTION 26255

SECTION 16271 - SERVICE ENTRANCE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of service-entrance work is indicated by drawings, schedules as directed by the Electric Power Utility Company, and as necessary to supply power to the building project.

B. New services: Provide electrical service entrance work as directed by the utility company and required by the contract documents. Contact the utility company prior to starting construction and coordinate the electric service work. Provide all service related work as required and as directed by the utility company.

C. Existing Service Removal: Provide removal of existing service and backfeed to existing electrical service entrance equipment as indicated by the contract documents. Notify the utility company of the proposed new service work. Comply with request and directions of the serving utility company where required. Maintain services to existing facilities during new service addition construction work.

D. Contractor shall be responsible for the cost and coordination of the new incoming service connection. The work done by the Power company to transfer power from the old incoming service to the new, and the cost by the power company to bring new service to the plant, including the transformer, shall be covered by a $20,000 allowance. The additional items noted below shall be excluded from the allowance scope of work and included in the Lump Sum Price of the project: Secondary conduit for electrical service from the new power company shall be the Contractor's responsibility to be included in the Lump Sum of the project. Contractor shall include and price three (3) 4" Schedule 40 PVC conduits (100 linear feet in total length) buried at 30" deep with marker tape/wire at 12" below grade. All elbows required shall be long, sweeping, and rigid, galvanized steel.

PART 2 - PRODUCTS:

2.1 SERVICE-ENTRANCE EQUIPMENT

A. General: Provide service-entrance equipment and accessories; of types, sizes, ratings, and electrical characteristics indicated, which comply with manufacturer's standard materials, design, and construction in accordance with published product information, and as required for complete installation; and as herein specified.

B. Overcurrent Protective Devices: Provide overcurrent protective devices complying with Electrical Work Basic Materials and Methods section "Overcurrent Protective Devices", in accordance with the following listing:

1. Molded Case Circuit Breakers.

2. Class L. Fuses.

3. Ground Fault Interrupting Systems

C. Cable/Wiring: Provide cable/wiring complying with Electrical Work Basic Materials and Methods section "Wires and Cables", in accordance with the utility company requirements.

D. Raceways: Provide raceways complying with Electrical Work Basic Materials and Methods section "Raceways", in accordance with the utility company utility requirements, code requirements, and as indicated by the drawings and schedules.

E. Where check metering is indicated on the drawings, provide KWH/KWD meter, current transformers, potential transformers, and accessories necessary for metering the class and type of service being metered. Metering must be installed and certified by a skilled meter installer.

F. Provide adjustable ground fault sensing and interrupting systems on the main service entrance devices.

PART 3 - EXECUTION

3.1 INSTALLATION OF SERVICE-ENTRANCE EQUIPMENT

A. Install service-entrance equipment as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that service-entrance

equipment fulfills requirements. Comply with applicable installation requirements of NEC and NEMA standards and the utility company requirements.

B. Coordinate with other electrical work, including utility company wiring, as necessary to interface installation of service-entrance equipment work with other work. Pay all fees and charges relating to the service entrance work.

C. Install fuses, if any, in service-entrance equipment.

D. Install ground-fault protection devices complying with NEC requirements and where indicated otherwise.

E. Set field-adjustable GFP devices and circuit breakers for pickup and time-current sensitivity ranges as for maximum selective coordination, subsequent to installation of devices and CB's.

F. Provide transformer and equipment pads, metering facilities and related service work in compliance with the utility company requirements.

G. Prior to the start of construction, submit copies of service related design drawings to the utility company serving the facility. This submittal shall include the proposed voltage, connected load and estimated demand. Notify the Engineer of any conflicts between the design and the power utility requirements.

3.2 GROUNDING

A. Provide tight system and equipment grounding and bonding connections for service-entrance equipment and wiring/cabling as indicated.

B. Extend a code size copper grounding electrode in any underground service entrance trench and connect to the utility ground grid.

C. Provide and install all grounding materials illustrated or as a minimum as required by the NEC.

3.3 ADJUST AND CLEAN

A. Adjust operating mechanisms for free mechanical movement.

B. Touch-up scratched or marred enclosure surfaces to match original finishes.

3.4 FIELD QUALITY CONTROL

A. Upon completion of installation of service-entrance equipment and electrical circuitry, energized circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

3.5 METERING

A. Provide service arrangement, metering equipment, cabinets, raceway, conductor, brackets and installation work as directed by the utility company.

B. Arrange for the permanent revenue metering arrangements in coordination with the Owner.

PART 4- PAYMENT

All electrical work shall be paid under the lump sum contract amount.

END OF SECTION 16271

SECTION 16272 - WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry but not utilize electric energy.

B. Types of electrical wiring devices in this section include the following:

1. Receptacles
2. Switches
3. Wall plates
4. Plugs
5. Plug connectors

1.2 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Bryant Electric Co.
2. Eagle Manufacturing
3. Harvey Hubbell Inc.

4. Pass and Seymour Inc.

5. Leviton Manufacturing

6. Wiremold Company

2.2 FABRICATED WIRING DEVICES:

A. General: Provide factory-fabricated wiring devices, in types, colors, and electrical ratings for applications indicated and complying with NEMA Stds pub No. WD 1, NEMAWD6, UL498, and DSCC W-C5966. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements, and complying with NEC and NEMA standards for wiring devices. Wiring devices other than those listed shall be of the type and rating required for service.

B. Wiring device color shall match existing.

C. Receptacles:

1. General-Duty Duplex: 2-pole, 3 wire, 20 amp 125 volt grounding receptacle. Molded urea or nylon face, side wired, screw terminals, self-grounding. Bryant Cat. No. 5342-1, or equal by Hubbell, P & S, Leviton, or Eagle.

2. General-Duty Simplex: 2-pole, 3 wire, 30 amp 250 volt grounding receptacle. Black color molded urea or nylon face, side wired, screw terminals, self-grounding. Bryant Cat. No. 9630-FR, or equal by Hubbell, P & S, Leviton or Eagle.

3. Special-Duty Combination: One boss 2 pole, 3 wire, 20 amp 125 volt, second boss 2 pole, 3 wire, 20 amp 250 volt, grounding receptacle. Molded urea or nylon face, side wired, screw terminals, self-grounding. Bryant Cat. No. 5492-I, or equal by Hubbell, P & S, Leviton or Eagle.

4. Special-Duty Isolated Ground: 2-pole, 3 wire, 20 amp 125 volt isolated ground receptacle. Orange color molded urea or nylon face, side wired, screw terminals. Bryant Cat. No. 5362IG, or equal by Hubbell, P & S, Leviton, or Eagle.

5. Special-Duty GFI Duplex: 2-pole, 3 wire, 20 amp, 125 volt grounding, ground fault, feed through, receptacle. Molded urea or nylon face, with wiring leads. Bryant Cat. No. GFR 53T-I, or equal by Hubbell, P & S, Leviton, or Eagle.

6. Special-Duty Range: 3-pole, 3 wire, 50 amp, 125/250 volt, straight blade, flush receptacle. Black molded melamine or phenolic face, back wired, screw terminals. Bryant Cat. No. 9306, or equal by Hubbell, P & S, Leviton, or Eagle.

D. Switches

1. Single Pole: General use snap switch rated 20 amp, 120/277 volt, (red face), side wired, screw terminals. Bryant Cat. No. 4901-I, or equal by Hubbell, P & S, Leviton, or Eagle.

2. Double Pole: General use snap switch rated 20 amp, 120/277 volt, (red face), side wired, screw terminals. Bryant Cat. No. 4902-1, or equal by Hubbell, P & S, Leviton or Eagle.

3. Three Way: General use snap switch rated 20 amp, 120/277 volt, (red face), side wired, screw terminals. Bryant Cat. No. 4903-I, or equal by Hubbell, P & S, Leviton or Eagle.

4. Four Way: General use snap switch rated 20 amp, 120/277 volt, (red face), side wired, screw terminals. Bryant Cat. No. 4904-I, or equal by Hubbell, P & S, Leviton, or Eagle.

5. Single Pole With 277 Volt Pilot Light: Special application snap switch rated 20 amp, 277 volt, (red face), clear handle with red pilot light, side wired, screw terminals. Bryant Cat. No. 4901 PLR277, or equal by Hubbell, Leviton, P & S., or Eagle.

6. Single Pole With 120 Volt Pilot Light: Special application snap switch rated 20 amp, 120 volt, (red face), clear handle with red pilot light, side wired, screw terminals. Bryant Cat. No. 4901PLR120, or equal by Hubbell, Leviton, P. & S., or Eagle.

E. Pendant Cord/Connector Devices

1. Description: Matching, locking-type plug and receptacle body connector, NEMA WD6, Configurations L5-20P and L5-20R, Heavy-Duty grade.

(a) Body: Nylon with screw-open cable-gripping jaws and provisions for attaching external cable grip.

(b) External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire stand, matched to cable diameter, and with attachment provision designed for corresponding connector.

F. Cord and Plug Sets

1. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.3 WIRING DEVICE ACCESSORIES:

A. Wall Plates: Provide single-switch and duplex outlet wall plates for wiring devices, of types, sizes, and with ganging and cutouts as indicated. Construct with metal screws for securing plates to devices; screw heads colored to match finish of plates; plate color shall match wiring devices. Provide wall plates possessing the following additional construction features:

1. Receptacle Wall Plates: Molded high impact nylon, smooth finish. Bryant Series 88000, or equal by Hubbell, Leviton, P & S, or Eagle.

2. Switch Wall Plates: Molded high impact nylon, smooth finish. Bryant Series 88000, or equal by Hubbell, Leviton, P & S, or Eagle.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES:

A. Install wiring devices as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate with other work, including painting, electrical box and wiring work, as necessary to interface installation of wiring devices with other work.

C. Install wiring devices only in electrical boxes which are clean; free from excess building materials, dirt, and debris.

D. Install galvanized steel wall plates in unfinished spaces.

E. Delay installation of wiring devices until wiring work is completed.

F. Where devices are installed in exterior locations, in cast metal boxes, provide while-in-use weatherproof metal cover for wiring device.

G. Delay installation of wall plates until after painting work is completed.

H. Adjust location of service poles to suit arrangement of partitions and furnishings.

3.2 PROTECTION OF WALL PLATES AND RECEPTACLES:

A. Upon installation of wall plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial completion, replace those items

which have been damaged, including those burned and scored by faulty plugs.

3.3 GROUNDING:

A. Provide electrically continuous, tight grounding connections for wiring devices, unless otherwise indicated.

3.4 TESTING:

A. Prior to energizing circuitry, test wiring devices for electrical continuity and proper polarity connections. After energizing circuitry, test wiring of devices to demonstrated compliance with requirements.

PART 4- PAYMENT

All electrical work shall be paid under the lump sum contract amount.

END OF SECTION 16272

SECTION 16276- SUPPORTING DEVICES

PART 1 GENERAL

1.01 Provide supporting devices which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified.

PART 2- PRODUCTS

Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:

A. Clevis Hangers: For supporting 2" rigid metal conduit; galvanized steel; with 2" diameter hole for round steel rod; approx. 54 pounds per 100 units.

B. C-Clamps: Black malleable iron; 2" rod size; approx. 70 pounds per 100 units.

Anchors: Provide anchors of types, sizes and materials indicated; and having the following construction features:

A. Lead Expansion Anchors: 2"; approx. 38 pounds per 100 units.

B. Toggle Bolts: Springhead; 3/16" x 4"; approx. 5 pounds per 100 units.

Install hangers, supports, clamps and attachments to support piping properly from structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together. Install supports with spacings indicated and in compliance with NEC requirements.

PART 3- PAYMENT

All electrical items and services shall be included under the lump sum contract amount.

END OF SECTION 16276

SECTION 16280 - OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of overcurrent protective device work is indicated by drawings, schedules, and code requirements.

B. Types of overcurrent protective devices in this section include the following:

1. Circuit breakers.

2. Fuses.

C. Provide overcurrent protection for all electrical work.

D. Maintenance Stock, Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every 5 installed units, but not less than one unit of each.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Circuit Breakers:

a. General Electric Co.

b. Siemens

c. Square D Co.

d. Cutler-Hammer

2. Fuses:

a. Bussmann Mfg Co.

b. Littlefuse Co.

2.2 CIRCUIT BREAKERS

A. General: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated or required, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.

B. Molded-Case Circuit Breakers: Provide factory-assembled, molded-case circuit breakers amperes rated as indicated on the drawings, 600-Volts for 480-Volt system and 240-Volts for 208Volt system, 60 HZ, 3-pole or single-pole as indicated with RMS symmetrical interrupting ratings as required by the application and location within the distribution system. Provide breakers with permanent thermal and instantaneous magnetic trips in each pole, ampere ratings as indicated. Construct with over-center, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication. Provide push-to-trip button on cover for mechanically tripping circuit breakers. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 C. Provide with mechanical screw type removable connector lugs, AL/CU rated.

2.3 FUSES

A. General: Except as otherwise indicated, provide fuses of types, sizes and ratings and electrical characteristics indicated or required, which comply with manufacturer's standard design, materials, and construction in accordance with published product information, and with industry standards and configurations.

B. Class L Fuses: Provide NEMA Class L fuses in current ratings indicated or required, for service entrances and main and feeder circuits.

C. Class J (K-5) Fuses: Provide NEMA Class J (K-5), dual-element types, with time delay of 10 seconds at 500% of rating, for use with switches.

D. Where equipment nameplate requires a specific fuse, the required fuse shall be furnished.

PART 3 - EXECUTION

3.1 INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES

A. Install overcurrent protective devices as indicated or required, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation and application of overcurrent protective devices.

B. Coordinate with other work, including electrical wiring work, as necessary to interface installation of overcurrent protective devices with other work.

C. Fasten circuit breakers without mechanical stresses, twisting or misalignment being exerted by clamps, supports, or cables.

D. Set field-adjustable circuit breakers for trip settings as indicated, subsequent to installation of devices.

E. Install fuses, if any, in fused circuit breakers and fused disconnect switches.

3.2 ADJUST AND CLEAN

A. Inspect circuit-breaker operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

3.3 FIELD QUALITY CONTROL

A. Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and for short-circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

PART 4- PAYMENT

All electrical work shall be paid under the lump sum contract amount.

END OF SECTION 16280

SECTION 16281 - MOTOR AND CIRCUIT DISCONNECTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of motor and circuit disconnect switch work is indicated by drawings, schedules, and code requirements. Types of motor and circuit disconnect switches in this section including the following:

1. Equipment disconnects.

2. Motor-circuit disconnects.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. General Electric Co.

2. Siemens

3. Square D Company

4. Cutler-Hammer

2.2 FABRICATED SWITCHES

A. Heavy-Duty Safety Switches: Provide surface-mounted, heavy-duty type, stainless steel enclosed safety switches, of types, sizes and electrical characteristics indicated; fusible type, rated 240 volts or 600 volts, 400 amperes and below, 60 hertz, 3 fusible blades, 4-poles, solid neutral; incorporating quick-make, quick-break type switches; so construct that switch blades are visible in OFF position with door open. Equip with operating handle which is integral part of enclosure base and whose position is easily recognizable, and is pad-lockable in OFF position; construct current carrying parts of high-conductivity copper, with silver-

tungsten type switch contacts, and positive pressure type reinforced fuse clips. Provide NEMA type 4XSS enclosure for outdoor.

B. Fuses: Provide fuses for safety switches, as recommended by switch manufacturer, of classes, types, and ratings needed to fulfill electrical requirements for service indicated. Provide fuses to match equipment label requirements when fuse information is furnished as part of the equipment label.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES

A. Install motor and circuit disconnect switches where required by code, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate motor and circuit disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.

C. Install disconnect switches used with motor-driven appliances, and motors and controllers within sight of controller position unless otherwise indicated.

D. Mount disconnect switches securely. Use stainless steel or silicon bronze fasteners for mounting outdoor switches.

E. Where building walls or equipment frames do not provide suitable mounting surface, provide galvanized unistrut frames or racks which will securely support the disconnect switch. Indoor frames may be painted unistrut frames.

PART 4- PAYMENT

All electrical work shall be paid under the lump sum contract amount.

END OF SECTION 16281

SECTION 16302- CONDUIT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal conduit.

B. Flexible metal conduit.

C. Liquid tight flexible metal conduit.

D. Nonmetal conduit.

E. Fittings and conduit bodies.

1.02 REFERENCES

A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.

B. ANSI C80.5 - Rigid Aluminum Conduit.

C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

D. ANSI/NFPA 70 - National Electrical Code.

E. NECA "Standard of Installation."

F. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

G. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.03. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle Products to site.

B. Accept conduit on site. Inspect for damage.

C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

D. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2.01 CONDUIT REQUIREMENTS

A. Minimum Size: 3/4 inch (19 mm) unless otherwise specified.

B. Underground Installations:
   1. Use rigid steel conduit.
   2. In or Under Slab on Grade: Use rigid steel conduit or thick wall nonmetallic conduit.
   3. Minimum Size: 3/4 inch (19 mm).

C. Outdoor Locations, Above Grade: Use rigid steel and intermediate metal conduit.

D. In Slab Above Grade: Use rigid steel conduit or intermediate metal conduit.

E. Wet and Damp Locations: Use schedule 80 PVC, thick wall nonmetallic conduit.

F. Where specifically indicated on the drawings, provide the type of conduit (size and material) indicated.

2.02. METAL CONDUIT

A. Manufacturers:

   1. Allied Tube.
   2. LTV Steel.
   3. Wheatland Tube.
   4. Or Approved Equal.

B. Rigid Steel Conduit: ANSI C80.1.

C. Rigid Aluminum Conduit: ANSI C80.5.

D. Intermediate Metal Conduit (IMC): Rigid steel.

E. Fittings and Conduit Bodies: ANSI/NEMA FB 1; material to match conduit, aluminum fittings may be used with steel conduit, all steel fittings.

2.03. PVC COATED METAL CONDUIT

A. Manufacturers:

1. Anamet.
2. Bay State Wire & Cable.
3. Robroy.
4. Or Approved Equal.

B. Description: NEMA RN 1; rigid steel conduit with external PVC coating, 40 mil (0.1 mm) thick.

C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel fittings with external PVC coating to match conduit.

2.04 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:

1. Alflex.
2. AFC.
3. Hubbell.
4. Or Approved Equal.

B. Description: Interlocked steel construction with PVC jacket.

C. Fittings: ANSI/NEMA FB 1.

2.05 NONMETALLIC CONDUIT

A. Manufacturers:

1. Carlon.
2. Bay State Wire & Steel.
3. Thomas & Betts.
4. Or Approved Equal.

B. Description: NEMA TC 2; Schedule 80 PVC.

C. Fittings and Conduit Bodies: NEMA TC 3.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install conduit in accordance with NECA "Standard of Installation."

B. Install nonmetallic conduit in accordance with manufacturer's instructions.

C. Arrange supports to prevent misalignment during wiring installation.

D. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

E. Fasten conduit supports to structure and surfaces.

F. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports

G. Arrange conduit to maintain neat appearance.

H. Route conduit parallel and perpendicular.

I. Route conduit in and under slab from point-to-point.

J. Do not cross conduits in slab.

K. Maintain adequate clearance between conduit and piping.

L. Maintain 12-inch (300 mm) clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).

M. Cut conduit square using saw or pipe cutter; de-burr cut ends.

N. Bring conduit to shoulder of fittings; fasten securely.

O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

P. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

Q. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender to fabricate factory elbows for bends in metal conduit larger than 2-inch (50 mm) size.

R. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

S. Provide suitable pull string in each empty conduit except sleeves and nipples.

T. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

U. Ground and bond conduit under provisions per Div. 16 and NEC.

V. Identify conduit.

W. All panelboard feeder conduit runs shown on the drawings shall be buried with a minimum of 24” of cover, or deeper as required by the NEC. Provide conduit encasement where required by applicable codes.

PART 4- PAYMENT

All electrical work shall be paid under the lump sum contract amount.

END OF SECTION 16302

SECTION 16303- BOXES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Outlet boxes.

B. Pull and junction boxes.

1.2 REFERENCES

A. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.

B. ANSI/NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

C. ANSI/NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.

D. ANSI/NFPA 70 - National Electrical Code.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

PART 2 PRODUCTS

2.1 OUTLET BOXES

A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, galvanized steel.
   1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 2 inch (13 mm) male fixture studs where required.
   2. Concrete Ceiling Boxes: Concrete type.

B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.

C. Cast Boxes: NEMA FB 1, Type FD, aluminum, cast feralloy. Provide gasketed cover by box manufacturer.

2.2 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

B. Install electrical boxes to present neat mechanical appearance.

C. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches (300 mm) of box.

D. Use gang box where more than one device is mounted together. Do not use sectional box.

E. Use cast outlet box in exterior locations exposed to the weather and wet locations.

F. Large Pull Boxes: Boxes larger than 100 cubic inches (1 600 cubic centimeters) in volume or 12 inches (300 mm) in any dimension.

1. Use surface-mounted cast metal box, sized per NEC and rated for the environment.

3.2 INTERFACE WITH OTHER PRODUCTS

A. Coordinate installation of outlet box.

B. Coordinate locations and sizes of required access doors with other Divisions.

PART 4- PAYMENT

All electrical work shall be paid under the lump sum contract amount.

END OF SECTION 16303

SECTION 16304- WIRES AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wire and cable.

B. Metal clad cable.

C. Wiring connectors and connections.

1.2 RELATED SECTIONS

A. Section 16302 - Conduit.

B. Section 16303 - Boxes.

1.3 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS - WIRE AND CABLE

A. Southwire.

B. Carol Cable Co.

C. Houston.

D. Or Approved Equal.

2.2 BUILDING WIRE AND CABLE

A. Description: Single conductor insulated wire.

B. Conductor: Copper

C. Insulation Voltage Rating: 600 volts.

D. Insulation: ANSI/NFPA 70, Type THHN-2/THWN, wet or dry locations, rated 90 degrees C.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that interior of panels has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Use stranded conductor for feeders and branch circuits, larger than 10 AWG.

C. Use stranded conductors for control circuits.

D. Use conductor not smaller than 12 AWG for power and lighting circuits.

E. Use conductor not smaller than 12 AWG for control circuits.

F. Use 10 AWG conductors for 20 amperes, 120-volt branch circuits longer than 75 feet (23 m).

G. Pull all conductors into raceway at same time.

H. Use suitable wire pulling lubricant for wire 4 AWG and larger.

I. Neatly train and lace wiring inside boxes, equipment, and panelboards.

J. Clean conductor surfaces before installing lugs and connectors.

K. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

L. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

M. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

N. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Identify each conductor with its circuit number or other designation indicated on Drawings.

3.5 FIELD QUALITY CONTROL

A. Inspect wire for physical damage and proper connection.

B. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

C. Verify continuity of each branch circuit conductor.

D. Verify continuity of grounded conductor.

PART 4- PAYMENT

All electrical work shall be paid under the lump sum contract amount.

END OF SECTION 16304

SECTION 16305 - ELECTRICAL CONNECTIONS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electric connections are hereby defined to include, but not necessarily limited to, connections for providing electrical power to equipment, control wiring connections, communication connections.

B. Types of electrical power and electrical system connections specified in this section includes, but is not limited to the following:

1. To motors.
2. To equipment.
3. To resistance heaters.
4. To HVAC equipment.
5. To motor starters.
6. To motor control equipment.
7. From motor starters to motors.
8. To plumbing equipment.
9. To lighting fixtures.
10. To transformers, inverters, rheostats, and similar current adjustment features of equipment.
11. To ground.
12. To master units of communication, signal, and alarm.

C. Motor starters and controls not furnished integrally with equipment are specified in applicable Electrical work sections along with installation specifications.

D. Refer to other specifications sections for motor starters and controls furnished with equipment; not work of this section.

E. Junction boxes and disconnect switches required for motors and other electrical units of equipment are specified in applicable Electrical work sections.

F. Refer to other specifications sections and the drawings for control system wiring work described and installed under Electrical work.

G. Refer to specification sections and plans of other work Divisions for specific individual equipment power requirements.

H. Furnish all labor and material and making power connections to all electric equipment furnished under the Architectural, Plumbing, Heating, Air Conditioning and equipment sections of the specifications and plans.

I. Provide the electrical installation of all control devices, including 115-volt, 1-phase firestats, mount all electrical equipment non-furnished as an integral part of the equipment, all control and power conduit, wiring, disconnect switches, etc., to make the installation. The mechanical section shall furnish all control devices for HVAC and plumbing systems.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. AMP Products Corp.
2. Appleton Electric Co.
3. Burndy Corp.
4. Ideal Industries, Inc.
5. T and B/Thomas and Betts Corp.

2.2 MATERIALS AND COMPONENTS

A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices and terminations of types indicated.

B. Metal Conduit, Tubing and Fittings: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements; comply with NEC requirements for raceways. Provide products complying with Electrical Work basic materials and methods section "Raceways", and in accordance with the raceway material required for the project.

C. Wire, Cable, and Connectors: Provide wires, cables, and

connectors complying with Electrical Work basic materials and methods section "Wires and Cables".

D. Wire: Unless otherwise indicated, provide wires/conductors for electrical connections which match wires/conductors of wiring supplying power.

E. Connectors and Terminals: Provide electrical connectors and terminals as recommended by connector and terminal manufacturer for intended applications.

F. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, solder, electrical soldering flux, wire nuts and cable ties as recommended for use by accessories manufacturers for type services indicated. Only twist-on type wire nuts will be permitted for branch circuit wiring.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Install electrical connections as indicated; in accordance with connector manufacturer's written instructions and with recognized industry practices, and complying with requirements of NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.

B. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Wherever possible, mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

C. Coordinate installation of electrical connections for equipment with equipment installation work.

D. Cover splices with electrical insulation equivalent to, or of higher rating, than insulation on conductors being spliced.

E. Prepare cables and wires by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated.

F. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

G. Tighten wire-binding connector screws firmly.

H. Provide flexible conduit for motor connections, and for other electrical equipment connections where subject to movement and vibration.

I. Provide liquid-tight metallic flexible conduit for connection of motors and for other electrical equipment where subject to movement and vibration, and also where subjected to one or more of the following conditions:

1. Exterior location.
2. Moist or humid atmosphere where condensate can be expected to accumulate.
3. Corrosive atmosphere.
4. Subjected to water spray.
5. Subjected to dripping oil, grease, or water.

J. Refer to basic materials and methods section for identification of electrical power supply conductor terminations with markers approved as to types, colors, letter and marker sizes, by Engineer. Affix markers at each point of termination, as close as possible to each point of connection.

END OF SECTION 260520

SECTION 16410 GROUNDING AND BONDING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding electrodes and conductors.

B. Equipment grounding conductors.

C. Bonding.

1.02 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

1.03 GROUNDING ELECTRODE SYSTEM

A. Metal underground water pipe, if available.

B. Metal frame of the building/pump station.

C. Concrete-encased electrode.

D. Rod electrodes.

1.04 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms.

PART 2 PRODUCTS

2.01 WIRE

A. Material: Stranded Copper.

B. Foundation Electrodes: 2/0 AWG

C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that final backfill, and compaction has been completed before driving rod electrodes.

3.02 INSTALLATION

A. Install Products in accordance with manufacturer's instructions.

B. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.

C. Provide grounding well pipe with cover at rod locations where indicated. Install well pipe top flush with finished grade.

D. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing.

E. Provide bonding to meet Regulatory Requirements and NEC.

F. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

3.03 INTERFACE WITH OTHER PRODUCTS

A. Interface with site grounding system.

B. Interface with lightning protection system, where present.

3.04 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

PART 4- PAYMENT

All electrical work shall be paid under the lump sum contract amount.

END OF SECTION 16410

SECTION 16480 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section provides specification requirements for adjustable frequency drives, variable speed drives or herein identified as VFD for use with AC motors.

B. The VFD manufacturer shall furnish, field test, adjust and certify all installed VFD's for satisfactory operation.

1.2 CODES/STANDARDS

A. VFD and options shall be c UL 508 listed.

B. The drive and options shall comply with the applicable requirements of the latest standards of ANSI, NEMA, National Electric Code, NEC, NEPU-70, IEEE 519-1992, FCC Part 15 Subpart J, CE96.

1.3 QUALITY ASSURANCE

A. Each drive shall be subjected to the following test and quality control procedures.

1. Every VFD shall be functionally tested under motor load. During this load test the VFD shall be monitored for correct phase current, Phase voltages, and motor speed. Correct Current Limit operation shall be verified by simulating a motor overload.

2. Verification of proper factory presets by scrolling through all parameters shall be performed to ensure proper microprocessor settings. The computer port should also verify that the proper factory settings are loaded correctly in the drive.

3. All options shall be functionally tested including operation of a motor in the ByPass mode if supplied. Proper heater coil installation in motor overload, if supplied, shall be verified.

1.4 SERVICE

A. The VFD manufacturer shall maintain and staff world-wide service centers. The manufacturers shall have the ability to test both the drives and motors in

these service centers.

1. Start-up shall be included for each VFD provided.

2. Service engineers shall be employed by the distributor and be certified by the manufacturer to provide start-up service including physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements. Distributor shall employ a factory certified automation engineer on-staff and on-call.

3. Contractor shall sub-contract the services of the integration sub-contractor for interfacing, final connections and programming of the variable frequency drives.

1.5 SHOP DRAWINGS AND ENGINEERING DATA

A. Complete shop drawing and engineering data shall be submitted in accordance with the requirements of Section 01 33 23, Shop Drawings, Product Data and Samples.

1.6 STORAGE AND PROTECTION

A. Store and protect the screening equipment in accordance with the requirements of Section 01 66 00, Storage and Protection.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit complete operation and maintenance data in accordance with the requirements of Section 01 78 23, Operating and Maintenance Data. Six copies of the O&M Manuals should be provided.

1.8 GUARANTEE

A. Provide a guarantee against defective and deficient equipment and workmanship in accordance with the requirements of Section 01 78 36, Warranties and Bonds.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of variable frequency drive):

1. Schneider Electric/Square D Co.

2. Allen Bradley

3. Engineer approved equal

2.2 GENERAL DESCRIPTION

A. The VFD shall convert the input AC mains power to an adjustable frequency and voltage as defined below:

1. The AC Drive manufacturer shall use a 6-Pulse full wave bridge rectifier design with 5% line reactors. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DX voltage. The power section shall be insensitive to phase rotation of the AC line. Drives to also be equipped with TCI VK1 output filters where indicated on the drawings.

B. The output power section shall change fixed DC voltage to adjustable frequency AC voltage. This section shall use insulated gate bipolar transistors (IGBT) or intelligent power modules (IPM) as required by the current rating of the motor.

2.3 CONSTRUCTION

A. The VFD shall be mounted as stand alone in a wall mounted or stand alone enclosure, as indicated on plans. Stand also enclosures shall be NEMA Type 12 fan filtered.

B. A mechanical interlock shall prevent an operator from opening the VFD door when the disconnect is in the “ON” position. Another mechanical interlock shall prevent an operator from placing the disconnect in the “ON” position while the VFD door is open. It shall be possible for authorized personnel to defeat these interlocks.

C. Provisions shall be provided for locking all disconnects in the “OFF” position.

D. The VFD shall include mechanically and electrically interlocked integrated isolation complete with a Class 20 thermal overload relay, circuit breaker disconnect, control circuit transformer and HAND/OFF/AUTO selector switch.

2.4 MOTOR DATA

A. The VFD shall be sized to operate AC motors per the pump supplier/manufacturer recommendations and to be non-overloading at pump FLA beyond the VFD nameplate, published rating.

2.5 APPLICATION DATA

A. The VFD shall be sized to operate a Variable Torque as required by the use.

B. The speed range shall be from a minimum speed of 0.5 Hz to a maximum speed of 400 Hz.

2.6 ENVIRONMENTAL RATINGS

A. The VFD shall be of construction that allows operation in a pollution Degree 3 environment. The VFD shall meet IEC 664-1 and NEMA ICS 1 Standards. VFD's that are only rated for Pollution Degree 2 environment shall not be allowed.

B. The VFD shall be designed to operate in an ambient temperature from -10

C. The storage temperature range shall be -25 to + 70 °C.

D. The maximum relative humidity shall be 95% at 40 °C, non-condensing.

E. The AC Drive shall be rated to operate at altitudes less than or equal to 3,300 ft (1000 m). For altitudes above 3,300 ft, de-rate the AC Drive by 1.2% for every 300 ft (100 m).

F. The AC Drive shall meet the IEC 600721-3-3-3M3 Operational Vibration Specification.

2.7 RATINGS

A. The AC Drive shall be designed to operate from an input voltage of and 460 ± 10% Vac.

B. The AC Drive shall operate from an input voltage frequency range of 60 Hz ± 2%.

C. The displacement power factor shall not be less than .95 lagging under any speed or load condition.

D. The efficiency of the AC Drive at 100% speed and load shall not be less than 96%.

E. The variable torque rated VFD over-current capacity shall be 110% for one minute.

F. The output carrier frequency of the VFD shall be randomly modulated and selectable at 2, 4, or 10 kHz depending on Drive rating for low noise

operation. No VFD with an operable carrier frequency above 10 kHz shall be allowed.

G. The output frequency shall be from 0.1 to 500 Hz for VFD's.

H. The VFD shall be able to develop rated motor torque at 0.5 Hz (60 Hz base) in a sensorless flux vector (SVC) mode using a standard induction motor without an encoder feedback signal.

2.8 PROTECTION

A. Upon power-up the VFD shall automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, dynamic brake failure, DC to DC power supply, control power and the pre-charge circuit.

B. The VFD shall be UL 508C listed for use on distribution systems with 100,000 A RMS available fault current. The VFD have a coordinated short circuit rating designed to UL 508C and NEMA ICS 7.1.09 and listed on the nameplate.

C. The Power Converter shall be protected against short circuits, between output phases and ground; and the logic and analog outputs.

D. The VFD shall have a minimum AC undervoltage power loss ride-through of 200 msec. The VFD shall have the user-defined option of frequency fold-back to allow motor torque production to continue to increase the duration of the power loss ride-through.

E. The VFD shall have a selectable ride through function that will allow the logic to maintain control for a minimum of one second without faulting.

F. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide up to 5 programmable restart attempts. The programmable time delay before restart attempts will range from 1 second to 600 seconds.

G. The deceleration mode of the VFD shall be programmable for normal and fault conditions. The stop modes shall include free-wheel stop, fast stop and DC injection braking.

H. Upon loss of the analog process follower reference signal, the VFD shall fault and/or operate at a user-defined speed set between software programmed low-speed and high-speed settings.

I. The VFD shall have solid state I
2t protection that is UL Listed and meets UL
508C as a Class 10 overload protection and meets IEC 60947. The minimum adjustment range shall be from .20 to 1.50% of the nominal current output of the VFD.

J. The VFD shall have a thermal switch with a user selectable pre-alarm that will provide a minimum of 60 seconds delay before over-temperature fault.

K. The VFD shall use bonded fin heat-sink construction for maximum heat transfer.

L. The VFD shall have a programmable fold-back function that will anticipate a controller overload condition and fold back the frequency to avoid a fault condition.

M. The output frequency shall be software enabled to fold back when the motor is overloaded.

N. There shall be three skip frequency ranges that can each be programmed with a selectable bandwidth of 2 or 5 Hz. The skip frequencies shall be programmed independently, back to back or overlapping.

2.9 ADJUSTMENTS AND CONFIGURATIONS

A. The VFD shall self-configure to the main operating supply voltage and frequency. No operator adjustments will be required.

B. Upon power-up, the VFD will automatically send a signal to the connected motor and store the resulting resistance data into memory. The inductance data will be measured during no-load operation when operating at a frequency between 20-60 Hz. The VFD will automatically optimize the operating characteristics according to the stored data.

C. The VFD will be factory pre-set to operate most common applications.

D. A choice of three types of acceleration and deceleration ramps will be available in the VFD software; linear, S curve and U curve.

E. The acceleration and deceleration ramp times shall be adjustable from 0.01 to 9000 seconds.

F. The volts per frequency ratios shall be user selectable to meet variable torque loads, normal and high-torque machine applications.

G. The memory shall retain and record run status and fault type of the past

eight faults.

H. Slip compensation shall be a software-enabled function.

I. The software shall have an “energy saving” function that will reduce the voltage to the motor when selected for variable torque loads. A constant volts/Hz ratio will be maintained during acceleration. The output voltage will then automatically adjust to meet the torque requirement of the load.

J. The VFD shall offer programmable DC injection braking that will brake the AC motor by injecting DC current and creating a stationary magnetic pole in the stator. The level of current will be adjustable between 10-110% of rated current and available from 0.1-30 seconds continuously. For continuous operation after 30 seconds, the current shall be automatically reduced to 50% of the nameplate current of the motor.

K. Sequencing logic will coordinate the engage and release thresholds and time delays for the sequencing of the VFD output, mechanical actuation and DC injection braking in order to accomplish smooth starting and stopping of a mechanical process.

2.10 OPERATOR INTERFACE

A. The operator interface terminal will offer the modification of VFD adjustments via a touch keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, faults, local control, adjustment storage, self-test and diagnostics will be in plain English. There will be a standard selection of four additional language built-in to the operating software as standard.

B. The display will be a high-resolution, LCD backlit screen capable of displaying graphics such as bar graphs as well as 8 lines of 240 x 160 pixels.

C. The VFD model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall all be listed on the drive identification display as viewed on the LCD display.

D. The display shall be configured for up to two bar graphs with numeric data selectable and scalable by the operator. A user defined label function shall be available. As a minimum the selectable outputs shall consist of speed reference, output frequency, output current, motor torque, output power, output voltage, line voltage, DC voltage, motor thermal state, drive thermal state, elapsed time, motor speed, machine speed reference and machine speed.

E. A single keystroke scrolling function shall allow dynamic switching between

display variables.

F. The terminal keypad will consist of programmable function keys. The functions will allow both operating commands and programming options to be preset by the operator. A hardware selector switch will allow the terminal keypad to be locked out from unauthorized personnel.

G. The operator terminal will offer a general menu consisting of parameter setting, I/O map, fault history, and drive configuration. A software lock will limit access to the main menu. The main menu will consist of keypad configuration, drive configuration, general configuration, diagnostic mode and drive initialization screens.

H. There will be arrow keys that will provide the ability to scroll through menus and screens, select or activate functions or increase the value of a selected parameter.

I. A data entry key will allow the user to confirm a selected menu, numeric value or allow selection between multiple choices.

J. An escape key will allow a parameter to return the existing value if adjustment is not required and the value is displayed. The escape function will also return to a previous menu display.

K. A RUN key and a STOP key will command a normal starting and stopping as programmed when the VFD is in keypad control mode. The STOP key must be active in all control modes.

L. The VFD shall have three LEDs mounted on the front panel to indicate functional status. A green LED will verify that the VFD power supply is on. A red LED indicator will indicated a VFD fault. A yellow LED indicator will designate a pending fault condition.

M. A user interface shall be available that is a WINDOWS ® based personal computer, serial communication link or detachable operator interface.

N. The keypad and all door mounted controls must match the rating of the enclosure.

O. Provide additional door mounted controls as indicated in control diagrams on the plans.

2.11 CONTROL

A. External pilot devices shall be able to be connected to a terminal strip for

starting/stopping the VFD, speed control and displaying operating status. All control inputs and outputs will be software assignable.

B. 2-wire or 3-wire control strategy shall be defined within the software. 2-wire control allows automatic restart of the VFD without operator intervention after a fault or loss of power. 3-wire control requires operator intervention to restart the VFD after a fault or loss of power.

C. The control power for the digital inputs and outputs shall be 24 Vdc.

D. The internal power supply incorporates an automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and not be damaged if shorted or excess current is pulled.

E. All logic connections shall be furnished on pull apart terminal strips.

F. There shall be (2) two software assignable, optically isolated analog inputs. The analog inputs will be software selectable and consist of the following configurations: 0-20 mA, 4-20 mA, 20-4 mA, x-20 mA (where x is user defined) 0 to 5 V, 1 to 5 V or 0 to 10 V.

G. There shall be four software assignable, optically isolated logic inputs that will be selected and assigned in the software. The selection of assignments shall consist of run/reverse, jog, plus/minus speed (2 inputs required), set point memory, preset speeds (up to 2 inputs), auto/manual control, controlled stop, terminal or keypad control, by-pass (2 inputs required), motor switching, and fault reset.

H. There shall be two software assignable optically isolated analog outputs that can be selected and assigned in the software. The analog output assignments shall be proportional to the following motor characteristics: frequency, current, power torque, voltage and thermal state. The output signal will be selectable from 0 to 20 mA or 4 to 20 mA.

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

J. There shall be a hardware input/output extension module that also provides interlocking and sequencing capabilities. The module shall be fully isolated and housed in a finger-safe enclosure with pull apart terminal strips. The module will add four logic inputs, two analog inputs, two relay outputs, and one analog output. All of the I/O will be user assignable in the software as previously defined.

K. The VFD door-mounted Control Island shall include a Power ON, Drive RUN, Drive Fault Light and Hand-Off-Auto selector switch with Manual Speed Potentiometer.

L. Provide and install pump moisture and thermal relays and shutdown on high thermal and moisture.

M. Each VFD shall be equipped with an ethernet communications card capable of communicating over Allen Bradley Ethernet/IP protocol. Ethernet communications cards shall be manufactured by the VFD manufacturer. Third party ethernet cards will not be acceptable.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify that the location is ready to receive work and the dimensions are as indicated.

B. Do not install VFD equipment until the building environment can be maintained within the service conditions required by the manufacturer.

3.2 PROTECTION

A. Before and during the installation, the VFD equipment shall be protected from site contaminants.

3.3 INSTALLATION

A. Installation shall comply with manufacturer's instructions, drawings and recommendations.

3.4 TRAINING

A. An on-site training course of 1 training day shall be provided by a representative of the VFD manufacturer plant and/or maintenance personnel.

END OF SECTION 16480

SECTION 16491 - TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide 3-phase, 4-wire transient voltage surge suppression (TVSS) or surge protection devices (SPD) as indicated on the power riser diagram.

B. As a minimum provide TVSS for all service entrance panels and locations indicated on drawings.

1.2 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections apply to this section.

1.3 DESCRIPTION

A. General: Transient voltage surge suppression (TVSS) or surge protection device (SPD) is the description and equipment required for the protection of all AC electrical circuits and electronic equipment from the effects of lightning induced voltages, external switching transients and internally generated switching transients.

1.4 REFERERENCE STANDARDS AND PUBLICATIONS

A. General: The latest edition of the following standards and publications shall comply to the work of this section:

ANSI/IEEE C84.1-1989, American National Standard for Electric Power Systems and Equipment - Voltage Ratings (60 Hertz)

ANSI/IEEE C62.41-1991, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

ANSI/IEEE C62.45-1992, IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits

Underwriters Laboratories UL 1449 Third Edition, Standard for Safety - Transient Voltage Surge Suppressors

Underwriters Laboratories, UL 1283, Standard for Safety Electromagnetic Interference Filters

National Fire Protection Association, NFPA 780 - National Electrical Code

IEEE Standard 142-1991, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)

ANSI/IEEE Standard 141-1999, IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE Red Book)

IEEE Standard 1100-1999, IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (IEEE Emerald Book)

FIPS Pub 94, Federal Information Processing Standards Publication - Guideline on Electrical Power for ADP Installations

National Electrical Manufacturer's Association LS-1, 1992 (NEMA MIL Standard 220A Method of Insertion-loss Measurement

1.5 MANUFACTURER QUALIFICATIONS

A. In order to establish a level of quality for these Construction Documents, Eaton's Innovative Technology shall be the basis of design.

B. All products submitted shall comply with the specifications of the Eaton's Innovative Technology model type specified herein. Manufacturers requesting product approval must meet or exceed the written specification contained herein.

C. The registered service mark (brand) must be owned by the Manufacturer. No private label accepted.

D. Manufacturer shall be ISO 9001 certified: Quality Systems – Model for Quality Assurance in Design, development, Production, Installation, and Servicing.

E. The Manufacturer must be regularly engaged in the manufacture of surge suppression products for the specified categories for no less than ten (10) years.

F. All surge protective devices for service entrance, distribution, and branch circuit protection within a facility shall be provided by a single manufacturer.

1.6 WARRANTY

A. The TVSS and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of ten (10) years from the date of substantial completion of service and activation of the system to which the suppressor is attached.

B. Any TVSS that shows evidence of failure or incorrect operation during the warranty period shall be replaced free of charge. Since “Acts of Nature” or similar statements typically include the threat of lightning to which the SPDs shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this section.

C. Exclusions and prorating will not be allowed. Warranties extended in excess of the manufacturer’s standard warranty are not acceptable for the purpose of the specification.

1.7COMPLIANCE REQUIREMENTS

A. A TVSS shall be listed in accordance with UL 1449 Third Edition, Standards for Safety, Transient Voltage Surge Suppressors and UL 1283, Standard for Safety, Electromagnetic Interference Filters.

B. ANSI/IEEE C62.41-1991Measured Limiting Voltage (Let-Thru) shall be reported with measurements taken from zero reference per NEMA LS-1.

C. SPD’s listed for 120/208V or 120/240V sub panels shall be UL 1283 listed, and must be a true sine wave tracking unit with EMI/RFI filtering. ANSI/IEEE C62.41-1991 Measured Limiting Voltage for sine wave tracking shall not exceed for A1 Ring Wave: L-N 60V; LG 100V; L-L 70V & N-G 70V (Measurements taken from zero reference per NEMA LS-1; 180 degree phase Angle).

D. TVSS shall have a response time of equal or less than 1 nanosecond and be of non-deteriorating design.

1. Repetitive surge withstanding capabilities for ANSI/IEEE Category 3 shall be no less than 18,000 pulse life for main service panel 300ka and higher, and no less than 18,000 for distribution and sub panels.

1.8 SUBMITTALS

A. Submit product data and shop drawings with complete description of material components.

B. Manufacturer's certified test data indicating the ability of the product to meet or exceed requirements of this specification.

C. Drawings, with dimensions, indicating TVSS mounting arrangement and lead length configuration, and mounting arrangement of any optional remote diagnostic equipment and assemblies.

D. All submittals for approved equals must be made ten (10) days prior to bid date.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The TVSS shall protect all modes and there shall be seven discrete suppression circuits; 3 modes connected Line to Ground, 3 modes connected Line to Neutral, and 1 mode connected Neutral to Ground for 3-phase, 4-wire, plus ground voltage system. Line to Neutral ground is not an acceptable substitute for Line to Ground. Line to Neutral to Line and Line to Ground to Line (in combination) will be acceptable for Line to Line protection.

B. Each TVSS must be in a Powered Steel NEMA Type 4 enclosure (IP66), and be of a no-power consuming design, except for indicator light.

C. TVSS unit(s) shall have integral surge counter and indicator status lights.

D. TVSS unit must not be affected by humidity, altitude, external EMI or RFI and must not generate EMI or RFI.

E. The TVSS shall be equal to Eaton's Innovative Technology based on Voltage & Amperage, and Repetitive Surge Withstanding

Capabilities as well as let-through voltage; and, 10 year warranty.

Area to be Protected	Sine Wave Tracking	Protector Model #	Warranty
A. Main Power			
277/480V ≤1600A		PTX160-3Y201	10 Years

120/208V ≤1600A		PTX160-3Y101	10 Years

B. Distribution Panels

120/208V <800A		PTX080-3Y101	10 Years
277/480V <800A		PTX080-3Y201	10 Years

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installing contractor shall install the parallel TVSS with short and straight conductors as practically possible.

B. The contractor shall follow the TVSS manufacturer's recommended installation practice as found in the equipment installation instructions (to be included in package with each unit).

C. The installation shall apply to all applicable codes.

D. All conductors associated with TVSS devices shall be installed in conduit. Minimum conductor size shall be #4 AWG copper.

PART 4- PAYMENT

All electrical work shall be paid under the lump sum contract amount.

END OF SECTION 16491