



RATTLESNAKE HILL 4.0 MG TANK AND TRANSMISSION PIPELINE PROJECTS

SPECIFICATION BOOK

**STANDARD SPECIFICATIONS
AND SPECIAL PROVISIONS**

for the

**RATTLESNAKE HILL 4.0 MG TANK AND
TRANSMISSION PIPELINE PROJECTS**

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SUNRISE ENGINEERING
STANDARD SPECIFICATIONS FOR CONSTRUCTION

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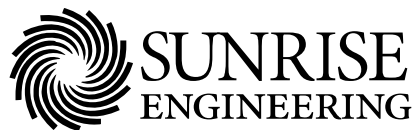
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00700.1 DEFINITIONS

Wherever used in the Contract Documents, the following terms shall have the meanings indicated which shall be applicable to both the singular and plural thereof:

ADDENDA - Written or graphic instruments issued prior to the execution of the Agreement which modify or interpret the Contract Documents, Drawings, and Specifications, by additions, deletions, clarifications, or corrections.

AGREEMENT OR CONSTRUCTION CONTRACT AGREEMENT - The written contract between the Owner and the Contractor covering the work to be performed; other Contract Documents are attached to the Agreement and made part thereof as provided therein.

BID - The offer or proposal of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

BIDDER - Any person, firm, or corporation submitting a bid for the Work.

BONDS - Bid, Performance, and Payment Bonds and other instruments of security, furnished by the Contractor and its surety in accordance with the Contract Documents.

CHANGE ORDER - A written order to the Contractor authorizing an addition, deletion, or revision in the Work within the general scope of the Contract Documents, or authorizing an adjustment in the Contract Price or Contract Time.

CONTRACT DOCUMENTS - The contract, including Advertisement for Bids (or notice to Contractors of Intention to Receive Bids). Instructions to Bidders, Bid, Bid Bond, Agreement, Payment Bond, Performance Bond, Notice of Award, Notice to Proceed, Change Order, Drawings, Specifications, Supplemental Instructions, Special Provisions and Addenda.

CONTRACT PRICE - The total monies payable to the Contractor under the terms and conditions of the Contract Documents.

CONTRACT TIME - The number of calendar days stated in the Contract Documents for the completion of the Work.

CONTRACTOR - The person, firm, or corporation with whom the Owner has executed the Agreement.

DRAWINGS - The part of the Contract Documents which show the characteristics and scope of the Work to be performed and which have been prepared or approved by the Engineer.

ENGINEER - Sunrise Engineering, Inc.

FIELD ORDER - A written order effecting a change in the Work not involving a material adjustment in the Contract Price or an extension of the Contract Time, issued by the Engineer to the Contractor during construction.

NOTICE OF AWARD - The written notice of acceptance of a bid, from the Owner to the successful Bidder, which also sets the time in which the Contract must be signed.

NOTICE TO PROCEED - Written communication issued by the Owner to the Contractor authorizing the Contractor to proceed with the Work and establishing the date of commencement and completion of the Work.

OWNER - A public or quasi-public body or authority, corporation, association, partnership, or individual for whom the Work is to be performed.

PROJECT - Synonymous with The Work, i.e., the total construction to be provided under the Contract Documents which may be the whole or a part as indicated elsewhere in the Contract Documents.

RESIDENT PROJECT REPRESENTATIVE - The authorized representative of the Owner who is assigned to the Project site or any part thereof.

SAMPLES - Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

SHOP DRAWINGS - All drawings, diagrams, illustrations, brochures, schedules, and other data which are prepared by the Contractor, subcontractor, manufacturer, supplier or distributor, which illustrate how specific portions of the Work shall be fabricated or installed.

SPECIAL PROVISIONS - A part of the Contract Documents, Additions and modifications to the Standard Specifications specifically prepared for the contract.

SPECIFICATIONS - A part of the Contract Documents consisting of written descriptions of a technical nature of materials, equipment, construction systems, standards and workmanship.

SUBCONTRACTOR - An individual, firm or corporation having a direct contract with the Contractor or with any other subcontractor for the performance of a part of the Work at the site.

SUBSTANTIAL COMPLETION - That date as certified by the Engineer when the construction of the Work or a specified part thereof is sufficiently completed, in accordance with the Contract Documents, so that the Work or specified part can be utilized for the purposes for which it is intended.

SUPPLEMENTAL GENERAL CONDITIONS - The part of the Contract Documents which amends or supplements these General Conditions.

SUPPLIER - Any person or organization who supplies materials or equipment for the Work, including that fabricated to a special design, but who does not perform labor at the site.

WORK – Labor or work necessary to produce the construction required by the Contract Documents, and all materials and equipment incorporated or to be incorporated in the project.

WRITTEN NOTICE - Any communications to any party of the Agreement relative to any part of the Agreement prepared in writing and considered delivered and the service thereof completed, when posted by certified or registered mail to the said party at its last given address, or delivered in person to said party or their authorized representative on the Work.

00700.2 ADDITIONAL INSTRUCTIONS AND DETAIL DRAWINGS

As necessary to carry out the Work required by the Contract Documents, the Engineer may furnish additional instructions and detail drawings to the Contractor. The additional drawings and instructions thus supplied will become a part of the Contract Documents. The Contractor shall carry out the Work in accordance with the additional detail drawings and instructions.

00700.3 SCHEDULES, REPORTS, AND RECORDS

00700.3.1 SUBMITTALS

The Contractor shall submit to the Owner such schedule of quantities and costs, progress schedules, payrolls, reports, estimates, records and other data where applicable as are required by the Contract Documents for the Work to be performed.

00700.3.2 CONSTRUCTION PROGRESS SCHEDULE

At the Pre-Construction Conference, the Contractor shall submit a construction progress schedule showing the order in which it proposes to carry on the Work, including dates at which they will start the various parts of the Work, estimated date of completion of each part and, as applicable:

- The dates at which special detail drawings will be required; and
- Respective dates for submission of Shop Drawings, the beginning of manufacture, the testing and the installation of materials, supplies, and equipment.

00700.3.3 SCHEDULE OF PAYMENTS

The Contractor shall also submit a schedule of payments that it anticipates will be earned during the course of the Work.

00700.4 DRAWINGS AND SPECIFICATIONS

00700.4.1 INTENDED PURPOSE

The intended purpose of the Drawings and Specifications is to furnish the Contractor with sufficient information and direction so that he can furnish all labor, materials, tools, equipment, and transportation necessary for the proper execution of the Work in accordance with the Contract Documents and to complete the Work in an acceptable manner, ready for use, occupancy or operation by the Owner.

00700.4.2 GOVERNANCE

In case of conflict between the Drawings and Specifications, the Specifications shall govern. Figure dimensions on Drawings shall govern over scale dimensions, and detailed Drawings shall govern over general Drawings.

00700.4.3 DISCREPANCIES

Any discrepancies found between the Drawings and Specifications and site conditions or any inconsistencies or ambiguities in the Drawings or Specifications shall be immediately reported to the Engineer, in writing, who shall promptly correct such inconsistencies or ambiguities in writing. Work done by the Contractor after its discovery of such discrepancies, inconsistencies or ambiguities shall be done at the Contractor's risk.

00700.5 SHOP DRAWINGS**00700.5.1 SUBMITTAL**

The Contractor shall provide Shop Drawings as may be necessary for the execution of the Work as required by the Contract Documents. Portions of the Work requiring a Shop Drawing or sample submission shall not begin until the Shop Drawing or submission has been approved by the Engineer. When submitted for the Engineer's review, Shop Drawings shall bear the Contractor's certification that the Contractor has reviewed, checked and approved the Shop Drawings and that they are in conformance with the requirements of the Contract Documents.

00700.5.2 REVIEW AND APPROVAL

The Engineer shall promptly review all Shop Drawings. The Engineer's approval of any Shop Drawings shall not release the Contractor from responsibility for deviations from the Contract Documents. The approval of any Shop Drawing which substantially deviates from the requirement of the Contract Documents shall be evidenced by a Change Order. A copy of each approved Shop Drawing and each approved sample shall be kept in good order by the Contractor at the site and shall be available to the Engineer.

00700.6 MATERIALS, SERVICES AND FACILITIES**00700.6.1 PURCHASING OF MATERIALS AND SUPPLIES**

It is understood that, except as otherwise specifically stated in the Contract Documents, the Contractor shall provide and pay for all materials, labor, tools, equipment, water, light, power, transportation, supervision, temporary construction of any nature, and all other services and facilities of any nature whatsoever necessary to execute, complete, and deliver the Work within the specified time. Materials, supplies or equipment to be incorporated into the Work shall not be purchased by the Contractor or any subcontractor subject to a chattel mortgage or under a conditional sale contract or other agreement by which an interest is retained by the seller or any third party financing entity.

00700.6.2 STORAGE OF MATERIALS AND EQUIPMENT

Materials and equipment shall be so stored as to insure the preservation of their quality and fitness for the Work. Stored materials and equipment to be incorporated in the Work shall be located so as to facilitate prompt inspection. The Contractor shall solely be responsible for making arrangements for suitable off-site storage of materials or equipment needed to accomplish the Work. Prior to using such area or facility, the Contractor shall obtain approval from the Engineer.

00700.6.3 FURNISHING AND INSTALLATION

Materials, supplies, and equipment shall be in accordance with samples submitted by the Contractor and approved by the Engineer. Manufactured articles, materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as directed by the manufacturer.

00700.7 INSPECTION AND TESTING

Inspection and testing of the Work shall meet the following requirements:

- All materials and equipment used in the construction of the Project shall be subject to adequate inspection and testing in accordance with generally accepted standards, as required and defined in the Contract Documents.
- The Owner shall provide all inspection and testing services not required by the Contract Documents.
- The Contractor shall provide at its expense any testing and inspection services required by the Contract Documents.
- If the Contract Documents, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction require any work to specifically be inspected, tested, or approved by someone other than the Contractor, the Contractor will give the Engineer timely notice of readiness. The Contractor will then furnish the Engineer the required certificates of inspection, testing, or approval.
- Inspections, tests or approvals by the Engineer or others shall not relieve the Contractor from its obligations to perform the Work in accordance with the requirements of the Contract Documents.
- The Engineer and the Engineer's representatives will at all times have access to the Work. In addition, authorized representatives and agents of any participating Federal or State agency shall be permitted to inspect all work, materials, payrolls, records of personnel, invoices of materials, and other relevant data and records. The Contractor will provide proper facilities for such access and observation of the Work and also for any inspection, or testing thereof.
- If any work is backfilled or covered contrary to the written instructions of the Engineer it must, if requested by the Engineer, be uncovered for its observation and replaced at the Contractor's expense.
- If the Engineer considers it necessary or advisable that covered work be inspected or tested by others, the Contractor, at the Engineer's request, will uncover, expose or otherwise make available for observation, inspection or testing as the Engineer may require, that portion of the Work in question, furnishing all necessary labor, materials, tools, and equipment. If it is found that such work is defective, the Contractor will bear all the expenses of such uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction. If, however, such work is not found to be defective, the Contractor will be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to such uncovering, exposure, observation, inspection, testing and reconstruction and an appropriate Change Order shall be issued.

00700.8 SUBSTITUTION OF MATERIALS

Whenever a material, article or piece of equipment is identified on the Drawings or Specifications by reference to brand name or catalogue number, it shall be understood that the reference is made for the purpose of defining the performance or other salient requirements and that other products of equal capacities, quality and function may be considered. The Contractor may recommend the substitution of a material, article, or piece of equipment of equal substance and function for those referred to in the Contract Documents by reference to brand name or catalogue number, and if, in

the opinion of the Engineer, such material, article, or piece of equipment is of equal substance and function to that specified, the Engineer may approve its substitution and use by the Contractor. Any cost reduction shall be deductible from the Contract Price and the Contract Documents shall be appropriately modified by Change Order. The Contractor warrants that if substitutes are approved, no major changes in the function or general design of the Project will result. Incidental changes or extra component parts required to accommodate the substitute will be made by the Contractor without a change in the Contract Price or Contract Time.

00700.9 PATENTS

The Contractor shall pay all applicable royalties and license fees. They shall defend all suits or claims for infringement of any patent rights and hold the Owner harmless from loss on account thereof, except that the Owner shall be responsible for any such loss when a particular process, design, or the product of a particular manufacturer or manufacturers is specified, however if the Contractor has reason to believe that the design, process or product specified is an infringement of a patent, the Contractor shall be responsible for such loss unless the Contractor promptly gives such information to the Engineer.

00700.10 SURVEYS, PERMITS, AND REGULATIONS**00700.10.1 SURVEYS**

The Owner shall furnish all boundary surveys and establish all base lines for locating the principal component parts of the Work together with a suitable number of bench marks adjacent to the Work as shown in the Contract Documents. From the information provided by the Owner, unless otherwise specified in the Contract Documents, the Contractor shall develop and make all detail surveys needed for construction such as slope stakes, batter boards, stakes for pipe locations and other working points, lines elevations, and cut sheets from information provided by the Engineer.

00700.10.2 BENCHMARKS

The Contractor shall carefully preserve benchmarks, reference points and stakes. If willful or careless destruction to these stakes, marks or reference points results from the activities of the Contractor, the Contractor shall be charged with the resulting expense for their restoration and for any mistakes that may be caused by their loss or disturbance.

00700.10.3 TEMPORARY PERMITS AND LICENSES

Permits and licenses of a temporary nature necessary for the execution of the Work shall be secured and paid for by the Contractor, unless otherwise stated in the Supplemental General Conditions. Permits, licenses and easements for permanent structures or permanent changes in existing facilities shall be secured and paid for by the Owner, unless otherwise specified. The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the Work as drawn and specified. If the Contractor observes that the Contract Documents are at variance therewith, it shall promptly notify the Engineer in writing, and any necessary changes shall be adjusted as provided in Subsection 00700.13, Changes in the Work.

00700.11 PROTECTION OF WORK, PROPERTY, AND PERSONS**00700.11.1 SAFETY PRECAUTIONS**

The Contractor will be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work and shall comply with all OSHA, State and local

requirements. This shall include taking all necessary precautions for the safety of, and will provide the necessary protection to prevent damage, injury or loss to:

- All employees on the Work and other persons who may be affected thereby,
- All the work and all materials or equipment to be incorporated therein, whether in storage on or off the site, and
- Other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of construction.

The Contractor, solely, shall be responsible for the safety, efficiency, and adequacy of its equipment, materials and methods; and for any damage which may result from their failure or improper operation and maintenance.

00700.11.2 LEGAL COMPLIANCE

The Contractor will comply with all applicable laws, ordinances, rules, regulations and orders of any public body having jurisdiction. The Contractor will erect and maintain, as required by the conditions and progress of the Work, all necessary safeguards for safety and protection. The Contractor will notify owners of adjacent utilities when execution of the Work may affect them. The Contractor will remedy all damage, injury or loss to any property caused, directly or indirectly, in whole or part, by the Contractor, any Subcontractor or anyone directly or indirectly employed by any of them or anyone for whose acts any of them be liable, except damage or loss attributable to the fault of the Contract Documents or to the acts or omissions of the Owner or the Engineer or anyone employed by either of them or anyone for whose acts either of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of the Contractor.

00700.11.3 EMERGENCIES

In emergencies affecting the safety of persons or the Work or property at the site or adjacent thereto, the Contractor, without special instruction or authorization from the Engineer or Owner, shall act to prevent threatened damage, injury or loss. The Contractor will give the Engineer prompt written notice of any significant changes in the Work or deviations from the Contract Documents caused thereby, and a Change Order shall thereupon be issued covering the changes and deviations involved.

00700.11.4 LIMITED USE OF WORKSITE

Unless otherwise allowed by these Contract Documents, the Contractor's use of the Work site shall be limited to its construction operations, including on-site storage of materials, on-site fabrication facilities and field offices.

00700.12 SUPERVISION BY CONTRACTOR

00700.12.1 SUPERVISORY RESPONSIBILITIES

The Contractor will supervise and direct the Work and will be solely responsible for the means, methods, techniques, sequences, and procedures of construction. The Contractor will employ and maintain on the Work a qualified supervisor or superintendent who shall have been designated in writing by the Contractor as the Contractor's representative at the site. The supervisor shall have full authority to act on behalf of the Contractor and all communications given to the supervisor

shall be as binding as if given to the Contractor. The supervisor shall be present on the site at all times as required to perform adequate supervision and coordination of the Work.

00700.12.2 ACCESS TO ROADS, STREETS, UTILITIES, ETC.

The Contractor shall make its own investigation of the condition of available public roads and their clearances, restrictions and limitations which affect access to the Work and shall further be responsible for construction and maintenance of any haul road required for accomplishment of the Work. Nothing herein shall be construed to entitle the Contractor to exclusive use of any public street, alleyway, or parking area during the performance of the Work. The Contractor shall not close any public street or roadway without obtaining permission from both the Engineer and the appropriate jurisdictional authority.

The Contractor shall so conduct operations as to not interfere with the authorized work of utility companies or other entities so authorized within these areas. When excavation is performed along a public street or roadway, access to fire hydrants, appropriate erosion protection measures and passage of traffic in at least one lane shall be provided at all times by the Contractor.

00700.13 CHANGES IN THE WORK

00700.13.1 CHANGE IN SCOPE OF WORK

The Owner may at any time, as the need arises, order changes within the scope of the Work without invalidating the Agreement. If such changes increase or decrease the amount due under the Contract Documents, or affect the time required for performance of the Work, an equitable adjustment shall be authorized by Change Order.

00700.13.2 CHANGE ORDER

A Change Order will be issued to decrease or increase actual quantities used which are different than those shown in the Bid Schedule. All changes must be fully approved in writing on a Change Order before they can be included in a payment to the Contractor. The Contract Change Order form will be used to document and authorize changes to the Contract Documents unless approval to use another form is obtained from the Engineer.

00700.13.3 FIELD ORDER

The Engineer may, at any time, issue a Field Order to interpret construction plans or to document communications with the Contractor concerning details of the Work. The Contractor shall proceed with the performance of any changes in the Work so ordered by the Engineer.

If the Contractor believes that such Field Order entitles it to a change in Contract Price and/or time, it shall give the Engineer written notice thereof within seven (7) days after the receipt of the Field Order. The Contractor then shall document and submit the basis for the change in Contract Price or time within thirty (30) days.

If the Owner does not accept that a Change Order is appropriate as outlined in 13.1 and 13.2 above, written notice of this decision shall be provided to the Contractor within 30 days of the receipt of the Contractor's documentation of the change in the Contract price or time. Any dispute shall thereafter be resolved pursuant to the terms of these Contract Documents. Regardless of any dispute by and between the Contractor, Engineer and Owner, Contractor shall perform all work required by the Field Order, Change Order or other contract document contained herein.

00700.14 CHANGES AFFECTING CONTRACT PRICE

00700.14.1 CHANGE ORDER

The Contract Price may be changed only by a Change Order. The value of any work covered by a Change Order or of any claim for increase or decrease in the Contract Price shall be determined by one or more of the following methods in the order of precedence listed below:

- Unit prices previously approved in the Contract Documents.
- An agreed lump sum price.
- The actual cost for labor, direct overhead, materials, supplies, equipment, and other services necessary to complete the Work. In addition there shall be added an amount to be agreed upon but not to exceed fifteen (15) percent of the actual cost of the Work to cover the cost of general overhead and profit.

00700.14.2 CHANGE IN QUANTITIES

The Owner reserves the right to change quantities listed in the Bid Schedule in order to revise the total Contract Price to match funding available in the Owner's budget.

00700.15 TIME FOR COMPLETION AND LIQUIDATED DAMAGES

00700.15.1 TIME FOR COMPLETION

The date of beginning, and the time for completion, of the Work are essential conditions of the Contract Documents and the Work embraced shall be commenced on a date specified in the Notice to Proceed. The Contractor will proceed with the Work at such rate of progress as to ensure full completion within the Contract Time.

Both the Contractor and the Owner expressly understand and agree, separately and jointly, that the Contract Time for the completion of the Work described herein is a reasonable time, taking into consideration the average climatic and economic conditions and other factors prevailing in the locality at the time of the Work.

0700.15.2 LIQUIDATED DAMAGES

If the Contractor shall fail to complete the Work within the Contract Time, or within any extension of time granted by the Owner, then the Contractor will pay liquidated damages to the Owner in the amount specified in the Contract for each calendar day that the Contractor is in default as stipulated in the Contract Documents.

The Contractor shall not be charged with liquidated damages or any excess cost when the delay in completion of the Work is due to the following, and the Contractor has promptly given written notice of such delay to the Owner or Engineer:

- To any preference, priority or allocation order duly issued by the Owner, or
- To unforeseeable causes beyond the control and without the fault or negligence of the Contractor, including but not restricted to, acts of God, or of the public enemy, acts of the Owner, acts of another Contractor in the performance of a contract with the Owner, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, and abnormal and unforeseeable weather; or
- To any delays of the subcontractor occasioned by any of the causes specified in the foregoing two paragraphs.

00700.16 CORRECTION OF WORK

The Contractor shall promptly remove from the premises all work rejected by the Engineer for failure to comply with the Contract Documents, whether incorporated in the construction or not. The Contractor shall promptly replace and re-execute that work in accordance with the Contract Documents and without expense to the Owner and shall bear the expense of making good all work of other Contractors destroyed or damaged by such removal or replacement. If the Contractor does not take action to remove such rejected work within ten (10) days after receipt of written notice, the Owner may remove such work and store the materials at the expense of the Contractor. All removal and replacement work shall be done at the Contractor's expense.

00700.17 SUBSURFACE CONDITIONS**00700.17.1 DISCOVERY OF CONDITIONS**

If, during the progress of the Work, previously known or unknown subsurface or latent physical conditions are encountered at the site which

- Differ materially from those indicated in the Contract Documents, or
- Differ materially from those ordinarily encountered and generally recognized as inherent in the Work provided for in the Contract Documents, are encountered at the site, then

the party discovering such conditions shall promptly notify the other party both verbally and in writing of the specifically differing conditions before the site is further disturbed and before the affected work is performed.

00700.17.2 OWNER INVESTIGATION

The Owner shall promptly investigate the conditions, and if found that such conditions do so materially differ and cause an increase or decrease in the cost of, or in the time required for, performance of the Work, an equitable adjustment shall be made and the Contract Documents shall be modified by a Change Order. Any claim of the Contractor for adjustment hereunder shall not be allowed unless the required written notice has been given; provided that the Owner may, if it determines the facts so justify, consider and adjust any such claims asserted before the date of final payment.

00700.18 SUSPENSION OF WORK AND TERMINATION OF CONTRACT**00700.18.1 SUSPENSION OF WORK BY OWNER**

At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to the Contractor and the Engineer. The notification will fix the date on which work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be allowed an adjustment in the Contract Price or an extension of the Contract Time, or both, directly attributable to any such suspension if Contractor makes a claim therefor as provided in Subsection 00700.30.

00700.18.2 TERMINATION OF CONTRACT FOR CAUSE BY OWNER**00700.18.2.1 GROUNDS FOR TERMINATION - The Owner may terminate the contract for cause as a result of the occurrence of any one or more of the following circumstances:**

- Contractor's persistent failure to perform the Work in accordance with the Contract Documents including, but not limited to, failure to supply sufficiently skilled workers or suitable materials or equipment or failure to adhere to the progress and payment schedule established under Subsection 00700.3.3.
- Contractor's disregard of Laws or Regulations of any public body having jurisdiction;
- Contractor's disregard of the authority of Engineer; or
- Contractor's violation in any substantial way of any provisions of the Contract Documents.

00700.18.2.2 ASSUMPTION OF WORKSITE BY OWNER - If one or more of the events described in the foregoing list occur, Owner may, after giving Contractor (and the surety, if any) seven days written notice, terminate the services of Contractor, exclude Contractor from the Site, and take possession of the Work and of all Contractor's tools, appliances, construction equipment and machinery at the Site and use the same to the full extent they could be used by Contractor (without liability to Contractor for trespass or conversion), incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and finish the Work as Owner may deem expedient.

00700.18.2.3 NO FURTHER PAYMENT TO CONTRACTOR - In such case, Contractor shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract Price exceeds all claims, costs, losses and damages (including, but not limited to all fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses and damages exceed such unpaid balance, Contractor shall pay the difference to Owner. The Engineer shall review such claims, costs, losses and damages incurred by Owner for reasonableness and, when approved by the Engineer, they shall be incorporated into the Contract as a Change Order. When exercising any rights or remedies under this paragraph Owner shall not be required to obtain the lowest price for the work performed.

00700.18.2.4 FURTHER RECOURSE AGAINST CONTRACTOR - Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue. Any retention or payment of monies due Contractor by Owner will not release Contractor from liability.

00700.18.3 TERMINATION OF CONTRACT FOR CONVENIENCE

The Owner, for his/her convenience, and without cause and without prejudice to any other right or remedy of Owner, may terminate the Contract by giving seven days written notice to Contractor and to Engineer. In such case, Contractor shall be paid (without duplication of any item) as follows:

- For completed and acceptable work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such work;
- For expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials or equipment as required by the Contract Documents in connection with uncompleted work, plus fair and reasonable sums for overhead and profit on such expenses;
- For all claims, costs, losses and damages (including, but not limited to all fees and charges of engineers, architects, attorneys and other professionals and all court or

arbitration or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers and others; and

- For reasonable expenses directly attributable to termination.

The Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

00700.18.4 TERMINATION OF CONTRACT BY CONTRACTOR

If, through no act or fault of Contractor, the Work is suspended:

- For more than 90 consecutive days by Owner, or
- Because of an order of a court or other public authority, or
- The Engineer fails to act on any Application for Payment within 30 days after it is submitted, or
- Owner fails for 30 days to pay Contractor any sum finally determined to be due, then

Contractor may, upon seven days written notice to Owner and to Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the Contract and recover from Owner payment on the same terms as provided in Subsection 00700.18.3.

00700.19 PAYMENTS TO THE CONTRACTOR

00700.19.1 APPLICATION FOR PAYMENT

00700.19.1.1 SUBMISSION OF APPLICATION - On or before the 10th day of each month, or as otherwise agreed, the Contractor will submit to the Engineer an Application for Payment for the work done in the previous month. The application shall be filled out and signed by the Contractor and be supported by such data as the Engineer may reasonably require.

The Application for Payment may include an allowance for the cost of major materials and equipment which have been delivered and suitably stored at or near the Work site but have not yet been incorporated into the Work. If payment is requested on this basis, the Application for Payment shall also be accompanied by such supporting data, satisfactory to the Owner, as will establish the Owner's title to the material and equipment and protect its interest therein, including proof of full coverage under applicable insurance. See Subsection 00700.21.4.5 below.

00700.19.1.2 ENGINEER'S APPROVAL - The Engineer will, within seven (7) days following receipt of each Application for Payment, review and either approve or reject the application. The Engineer will indicate approval in writing and present the request for payment to the Owner or trustee as applicable. If the application is rejected, the Engineer will return the application to the Contractor indicating in writing the reasons for rejecting it. In the latter case, the Contractor may make necessary corrections or revisions and resubmit the Application for Payment.

00700.19.1.3 PAYMENT BY OWNER - The Owner or trustee will, within thirty (30) days of presentation of an approved Application for Payment, pay the Contractor a progress payment on the basis of the Application. The Owner shall deduct, retain and administer the retainage amounts of each payment in accordance with provisions of applicable state and local laws. Unless otherwise specified in the Construction Contract Agreement or in the Special Provisions, amounts deducted, retained, administered and paid shall be as described below:

- As directed by the Engineer, the Owner shall deduct and retain up to ten (10) percent of the amount of each payment until there has been ninety-five (95) percent completion and acceptance of all work covered by the Contract Documents.
- When not less than ninety-five (95) percent of the Work has been completed, the Engineer may reduce the amount of retainage to one and one-half percent of the original Contract Price to ensure completion.
- Upon completion and acceptance of a part of the Work on which the price is stated separately in the Contract Documents, payment may be made in full, including retained percentages, less authorized deductions.

00700.19.2 NON-PAYMENT BY OWNER

Unless otherwise specified in the Agreement or elsewhere in the Contract Documents, if the Owner fails to make payment thirty (30) days after approval by the Engineer, in addition to other remedies available to the Contractor, there shall be added to each such payment interest at the current prime rate commencing on the first day after said payment is due and continuing until the payment is received by the Contractor.

00700.19.3 WITHOLDING OF PAYMENT BY OWNER

00700.19.3.1 DEFICIENCIES IN THE WORK - As a result of subsequently discovered evidence, the Owner may, after consultation with the Engineer, withhold or nullify the whole or part of any payment application as may be necessary to protect the Owner from loss for:

- Defective work not remedied
- Claims filed
- Failure of the Contractor to make payments properly to subcontractors or suppliers.
- Damage to another Contractor
- Performance of the Work in violation of the terms of the Contract Documents.

In the event this situation arises where the Work is substantially complete but lacks testing, cleanup and/or corrections, quantities may be reduced proportionately in the payment to cover such testing, cleanup and/or corrections.

When the deficiencies of the contract terms contributing to this action are corrected, payment will be made for amounts due in full.

00700.19.3.2 CONTINUED NON-PERFORMANCE - In the instance of continued non-performance or non-compliance on the part of the Contractor in making remedies or corrections to deficiencies in the Work, the Owner may himself, or with the help of another contractor or hired worker, perform the work necessary to bring about the required corrections and/or remedies. The cost of such work, to include both labor and materials, will be withheld from payments otherwise due to the Contractor until the situation has been resolved.

00700.19.3.3 REFERENCE - See also Subsection 00700.19.4 next below.

00700.19.4 PAYMENT INDEMNIFICATION

00700.19.4.1 SATISFACTION OF OBLIGATIONS - The Contractor will indemnify and save the Owner or the Owner's agents harmless from all claims growing out of the lawful demands of subcontractors, laborers, workmen, mechanics, material men, and furnishers of machinery and parts thereof, equipment, tools, and all supplies, incurred in the furtherance of the performance of the Work.

The Contractor shall, at the Owner's request, furnish satisfactory evidence that all obligations of the nature designated above have been paid, discharged, or waived. If the Contractor fails to do so, the Owner may, after having notified the Contractor, pay unpaid bills or withhold from the Contractor's unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged whereupon payment to the Contractor shall be resumed, in accordance with the terms of the Contract Documents, but in no event shall the provisions of this sentence be construed to impose upon the Owner any obligations to either the Contractor, the Contractor's surety, or any third party. In paying any unpaid bills of the Contractor, any payment so made by the Owner shall be considered as a payment made under the Contract Documents by the Owner to the Contractor and the Owner shall not be liable to the Contractor for any such payments made in good faith.

00700.19.4.2 REFERENCE - See also Subsection 00700.24 below.

00700.19.5 FINAL PAYMENT ON COMPLETION OF WORK

Upon completion and acceptance of the Work, the Engineer shall issue a certificate, attached to the final Application for Payment, that the Work has been accepted under the conditions of the Contract Documents. The entire balance found to be due the Contractor, including the retained percentages, but except such sums as may be lawfully retained by the Owner, shall be paid to the Contractor within sixty (60) days (or per state law) of completion and acceptance of the Work.

00700.19.6 ACCESS TO PREMISES AND FACILITIES

00700.19.6.1 USE OF COMPLETED WORK – At any time, the Owner may, with the approval of the Engineer and with the concurrence of the Contractor, use any completed or substantially completed portions of the Work. Such use shall be authorized by issuance of a Notice of Substantial Completion and shall not constitute an acceptance of such portions of the Work.

00700.19.6.2 NON-CONTRACT WORK - The Owner shall have the right to enter the premises for the purpose of doing work not covered by the Contract Documents. This provision shall not be construed as relieving the Contractor of the sole responsibility for the care and protection of the Work, or the restoration of any damaged work except such as may be caused by agents or employees of the Owner.

00700.20 ACCEPTANCE OF FINAL PAYMENT AS RELEASE

The acceptance by the Contractor of final payment shall be and shall operate as a release to the Owner of all claims and all liability to the Contractor other than claims in stated amounts as may be specifically excepted by the Contractor for all things done or furnished in connection with this Work and for every act and neglect of the Owner and others relating to or arising out of this Work.

Any payment, however, final or otherwise, shall not release the Contractor or its sureties from any obligations under the Contract Documents or the Performance Bond and Payment Bond.

00700.21 INSURANCE

00700.21.1 PURCHASE OF INSURANCE

The Contractor shall purchase insurance to protect against liability, loss, or other expense arising from damage to property or injury to or death of any person or persons incurred in anyway out of, in connection with, or resulting from the Work provided hereunder. The Contractor shall purchase the insurance from reliable insurance companies authorized to do business in the state in which the Work is to be performed. The insurance shall be rated "A" or better and have a financial size

category of Class VII or larger as determined by A.M. Best Company at the time the Contract Documents are executed.

00700.21.2 CERTIFICATE OF INSURANCE.

Certificates of Insurance acceptable to the Owner shall be filed with the Owner prior to commencement of the Work. Such Certificates shall identify the Owner and Engineer (and any other party identified in the Supplemental General Conditions) as additional insured. These Certificates shall contain a provision that coverage afforded under the policies will not be materially changed or reduced unless at least thirty (30) days prior written notice has been given to the Owner.

00700.21.3 COVERAGE OF INSURANCE

Insurance purchased by the Contractor shall provide protection against claims including, but not limited to, those set forth below, which may arise out of, or result from, the Contractor's execution of the Work, whether such execution be by the Contractor or by any subcontractor or by any other person directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable:

- Claims under workmen's compensation, disability benefit and other similar employee benefit acts;
- Claims for damages because of bodily injury, occupational sickness or disease, or death of its employees;
- Claims for damages because of bodily injury, sickness or disease or death of any person other than its employees;
- Claims for damages insured by usual personal injury liability coverage which are sustained (1) by any person as a result of an offense directly or indirectly related to the employment of such person by the Contractor, or (2) by any other person; and
- Claims for damages because of injury to or destruction of tangible property, including loss of use resulting therefrom.

00700.21.4 REQUIRED INSURANCE

The required insurance shall be the following or equivalent, where each applies:

00700.21.4.1 WORKERS COMPENSATION - Workers Compensation Insurance and Employer's Liability Insurance that provide statutory benefits. The Best's rating requirements are waived for coverage provided by the Worker's Compensation Fund within the state in which the Project is located. The Contractor shall require all subcontractors at any tier to take and maintain similar policies of Workers' Compensation Insurance.

00700.21.4.2 COMPREHENSIVE - Comprehensive General Liability Insurance and/or Commercial General Liability Insurance, including coverage for premises and operations, explosion, collapse and underground hazards, contractual (including this contract, and personal injury including employees) with limits of not less than \$1,000,000 combined single limit per occurrence, and not less than \$2,000,000 aggregate which shall be designated as applying to this contract. If this insurance is made on a "claims made" basis, the certificate of insurance required above shall indicate, and the policy shall contain, an extended reporting period provision or similar "tail" provision such that claims reported up to one (1) year beyond the date of completion of this contract are covered.

- 00700.21.4.3 AUTOMOBILE - Comprehensive Automobile Liability insurance including owned, hired, and non-owned automobiles with limits not less than \$1,000,000 combined single limit per accident.
- 00700.21.4.4 AIRCRAFT - The Contractor using its own aircraft, or employing aircraft in connection with the Work performed under these Contract Documents shall maintain Aircraft Liability Insurance with a combined single amount of not less than \$1,000,000 per occurrence.
- 00700.21.4.5 PROPERTY - Unless otherwise provided, the Contractor shall purchase property insurance in an amount equal to the initial Contract Price plus any subsequent modifications thereto for the entire Work of the Project on a replacement cost basis with any applicable deductibles not to exceed \$5,000.

Property insurance shall be on an all-risk form. It shall provide extended coverage and shall insure against the perils of fire and physical loss or damage including, without duplication of coverage, flood, earth movement, theft, vandalism, malicious mischief, collapse, falsework, temporary buildings, and debris removal including demolition occasioned by enforcement of any applicable requirements. It shall include reasonable compensation for Engineer's services required as a result of such insured loss. Coverage for other perils shall not be required unless otherwise called for in the Contract Documents.

Such property insurance shall be maintained, unless otherwise provided in the Contract Documents, or otherwise agreed to in writing by all persons and entities who are beneficiaries of such insurance, until final payment has been made or until no person or entity other than the Owner has an insurable interest in the Work to be covered. This insurance shall include interests of the Owner, the Contractor, and subcontractors in the Work. The form of this policy for this coverage shall be Completed Value. If the Owner is damaged by the failure of the Contractor to maintain such insurance, then the Contractor shall bear all reasonable costs properly attributed thereto.

Unless otherwise provided in the Contract Documents, and with written approval of the Owner, this property insurance shall cover portions of the Work stored off the site, at the value established in the approval, as well as portions of the Work in transit.

00700.21.5 MAINTENANCE OF INSURANCE

Unless otherwise provided, all required insurance shall remain in force during the entire Contract Time.

00700.21.6 ARRANGEMENT OF POLICIES

Any policy required by this section may be arranged under a single policy for the full limit required, or by a combination of underlying policies with the balance provided by an Excess or Umbrella Liability Policy.

00700.21.7 ADDITIONAL INSURED

All liability insurance policies required hereunder shall provide that the Owner, Engineer and all departments, authorities and instrumentalities, and while acting within the scope of its duties, all of its elected or appointed officers, employees and authorized volunteers as well as advisory committees, shall be named as additional insured. Such policies shall also provide that coverage for the above insured is primary and not contributing.

00700.21.8 INSOLVENCY OF INSURER

Irrespective of the requirements as to insurance to be carried by the Contractor as provided herein; insolvency, bankruptcy or failure of any insurance company to pay all claims accruing, shall not be held to relieve the Contractor of any obligations hereunder.

00700.22 CONTRACT SECURITY**00700.22.1 PROVISION OF BONDS**

The Contractor shall within ten (10) days after the receipt of the Notice of Award, furnish the Owner with a Performance Bond and a Payment Bond in penal sums equal to the amount of the Contract Price, conditioned upon the performance by the Contractor of all undertakings, covenants, terms, conditions, and agreements of the Contract Documents, and upon the prompt payment by the Contractor to all persons supplying labor and materials in the execution of the Work provided by the Contract Documents. Such bonds shall be executed by the Contractor and a corporate bonding company licensed to transact such business in the state in which the Work is to be performed and named on the current list of "Surety Companies Acceptable on Federal Bonds" as published in the Treasury Department Circular Number 570. The expense of these bonds shall be borne by the Contractor.

00700.22.2 BANKRUPTCY OF SURETY

If at any time a surety on any such Bond is declared bankrupt or loses its right to do business in the state in which the Work is to be performed or is removed from the list of Surety Companies accepted on Federal bonds, Contractor shall within ten (10) days after notice from the Owner to do so, substitute an acceptable bond (or bonds) in such form and sum and signed by such other surety or sureties as may be satisfactory to the Owner. The premiums on such bond shall be paid by the Contractor. No further payments to the Contractor shall be deemed due nor shall be made until the new surety or sureties shall have furnished an acceptable Bond to the Owner.

00700.23 ASSIGNMENTS

Neither the Contractor nor the Owner shall sell, transfer, assign, or otherwise dispose of the Contract or any portion thereof, or of its right, title, or interest therein, or its obligations thereunder, without written consent of the other party.

00700.24 INDEMNIFICATION**00700.24.1 OWNER AND ENGINEER HELD HARMLESS**

In addition to indemnification provisions of the Contract, the Contractor will indemnify and hold harmless the Owner and the Engineer and its agents and employees from and against all claims, damages, losses and expenses including attorney's fees arising out of or resulting from the performance of the Work, provided that any such claims, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property including the loss of use resulting therefrom; and is caused in whole or in part by any negligent or willful act or omission of the Contractor, and subcontractor or supplier, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable.

00700.24.2 WORKMAN'S COMPENSATION AND EMPLOYEE BENEFITS

In any and all claims against the Owner or the Engineer, or any of their agents or employees, by any employee of the Contractor, any subcontractor, anyone directly or indirectly employed by any

of them or anyone for whose acts any of them may be liable, the indemnification obligation shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for the Contractor or any subcontractor under workmen's compensation acts, disability benefit acts or other employee benefits acts.

00700.24.3 ENGINEER LIABILITY

The obligation of the Contractor under this paragraph shall not extend to the liability of the Engineer, its agents or employees arising out of the preparation or approval of maps, Drawings, opinions, reports, surveys, Change Orders, designs or Specifications.

00700.25 SEPARATE CONTRACTS**00700.25.1 OTHER PROJECT CONTRACTS**

The Owner reserves the right to let other contracts in connection with this Project. The Contractor shall afford other contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work, and shall properly connect and coordinate the Work with theirs. If the proper execution or results of any part of the contractor's work depends upon the work of any other Contractor, the Contractor shall inspect and promptly report to the Engineer any defects in such work that render it unsuitable for such proper execution and results.

00700.25.2 ADDITIONAL PROJECT RELATED WORK

The Owner may perform additional work related to the Project, or the Owner, may let other contracts containing provisions similar to these. The Contractor will afford the other contractors who are parties to such contracts (or the Owner, if the Owner is performing the additional work), reasonable opportunity for the introduction and storage of materials and equipment and the execution of work, and shall properly connect and coordinate the contractor's work with theirs.

00700.25.3 WRITTEN NOTICE OF ADDITIONAL WORK

If the performance of additional work by other contractors or the Owner is not noted in the Contract Documents prior to the execution of the Contract, written notice thereof shall be given to the Contractor prior to starting any such additional work. If the Contractor believes that the performance of such additional work by the Owner or others involves the Contractor in additional expense or entitles it to an extension of the Contract Time, the Contractor may make a claim therefor as provided in Subsections 00700.14 and 00700.15 of these General Conditions.

00700.26 SUBCONTRACTING

The Contractor may utilize subcontractors under the following conditions:

- The Contractor may utilize the services of specialty subcontractors on those parts of the Work which, under normal contracting practices, are performed by specialty subcontractors.
- The Contractor shall not award work to subcontractor(s), in excess of fifty (50%) percent of the Contract Price, without prior written approval of the Owner.
- The Contractor shall be as fully responsible to the Owner for the acts and omissions of its subcontractors and suppliers, and of persons either directly or indirectly employed by them, as the Contractor is for the acts and omissions of persons directly employed by itself.
- The Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the Work to bind subcontractors to the Contractor by the terms of the Contract Documents insofar as applicable to the Work of subcontractors and to give the Contractor the same power

as regards terminating any subcontract that the Owner may exercise over the Contractor under any provision of the Contract Documents.

- Nothing contained in this Contract shall create any contractual relation between any subcontractor or supplier and the Owner.

00700.27 ENGINEER'S AUTHORITY

The Engineer shall act as the Owner's representative during the construction period and shall otherwise perform as follows:

- The Engineer shall decide questions which may arise as to quality and acceptability of materials furnished and work performed.
- The Engineer shall interpret the intent of the Contract Documents in a fair and unbiased manner.
- The Engineer will make visits to the site and determine if the Work is proceeding in accordance with the Contract Documents.
- The Engineer will not be responsible for the construction means, controls, techniques, sequences, procedures, or construction safety.
- The Engineer shall promptly make decisions relative to interpretation of the Contract Documents.
- The Engineer will carefully enforce the intent of the Contract Documents in regard to the quality of materials, workmanship and execution of the Work. Inspections may be made at the factory or fabrication plant of the source of material supply, when determined necessary by the Engineer.

00700.28 LAND AND RIGHTS-OF-WAY**00700.28.1 OWNER'S RESPONSIBILITY**

Prior to issuance of Notice to Proceed, the Owner shall obtain all land and rights-of-way necessary for carrying out and for the completion of the Work to be performed pursuant to the Contract Documents, unless otherwise mutually agreed. The Owner shall provide to the Contractor information which delineates and describes the lands owned and rights-of-way acquired.

00700.28.2 CONTRACTOR'S RESPONSIBILITY

The Contractor shall provide at its own expense and without liability to the Owner any additional land and access thereto that the Contractor may desire for temporary construction facilities or for storage of materials.

00700.29 GUARANTEE

The Contractor shall guarantee all materials and equipment furnished and work performed for a period of one (1) year from the date Final Acceptance. The Contractor warrants and guarantees for a period of one (1) year from the date of Final Acceptance of the Work that the completed Work is free from all defects due to faulty materials or workmanship and the Contractor shall promptly make such corrections as may be necessary by reason of such defects including the repairs of any damage to other parts of the Work resulting from such defects. The Owner will give notice of observed defects with reasonable promptness. In the event that the Contractor should fail to make such repairs, adjustments, or other work that may be made necessary by such defects, the Owner may do so and charge the Contractor the cost thereby incurred. The Performance Bond shall remain in full force and effect through the guarantee period.

00700.30 ARBITRATION

00700.30.1 DECISION BY ARBITRATION

All claims, disputes, and other matters in question arising out of, or relating to, the Contract Documents or the breach thereof, except for claims which have been waived by making an acceptance of final payment as provided by Subsection 00700.20 of these General Conditions, may be decided by arbitration if the parties mutually agree. Any agreement to arbitrate shall be specifically enforceable under the prevailing arbitration law. The award rendered by the arbitrators shall be final, and judgment may be entered into any court having jurisdiction thereof.

00700.30.2 WRITTEN REQUEST FOR ARBITRATION

Notice of the request for arbitration shall be filed in writing with the other party to the Contract Documents and a copy shall be filed with the Engineer. Request for arbitration shall in no event be made on any claim, dispute, or other matter in question which would be barred by the applicable statute of limitations.

00700.30.3 CONTINUATION OF WORK

The Contractor will carry on the Work and maintain the progress schedule during any arbitration proceedings, unless otherwise mutually agreed to in writing.

00700.31 TAXES

The Contractor will pay all sales, consumer, use and other similar taxes required by the law of the place where the Work is performed.

01019.1 DESCRIPTION

This Section covers measurement and payment practices utilized by Sunrise Engineering in performing its contract management services according to the requirements of these Specifications and other parts of the Contract Documents.

01019.2 MEASUREMENT**01019.2.1 METHODS**

The method of measurement and computations to be used in determination of quantities of material furnished, and of work performed under the Contract, will be those methods generally recognized as conforming to good engineering practice.

When items of improvement, equipment, or service referred to herein as "work" are shown on the plans and/or called for in the specifications for the Contractor to furnish, install, or provide, the items of work shall be measured and paid for in one of two ways. First, if the item of work is considered incidental to other items in the Bid Schedule, no separate measurement and payment shall be made and no separate bid item in the bid schedule will appear. In this case measurement and payment for this work shall be included by the Contractor in other bid items on the bid schedule. Second, when shown separately on the bid schedule, the item of work shall be measured as called for in the specifications and paid for at the contract unit price for that work.

01019.2.2 ACCURATE PRICING

The Bidder shall include a price for all bid items in the Bid Schedule and the Schedule of Values if required. Failure to do so may render the Bid non-responsive and may cause its rejection. All bids will be checked for errors. In the event the total "amount" indicated on the Bid schedule for a bid item does not equal the product of the unit price times the estimated quantity, the unit price shall govern, and the amount will be corrected accordingly. In the event the Bid Total does not agree with the sum of the prices bid on the individual bid items, the individual item prices shall govern and the total for the Bid schedule will be corrected accordingly. The Contractor shall be bound by any such corrections. For "Lump Sum" bid items, where applicable, the total shown on the Schedule of Values shall equal the amount entered for the corresponding bid item on the Bid schedule.

01019.2.3 U.S. STANDARD MEASURE

All work completed under this Contract will be measured by U.S. standard measure for the units described herein. Work performed by the Contractor will be measured in those units in accordance with the procedure described herein.

01019.2.4 MEASUREMENT BY ENGINEER

Since the quantities appearing on the Bid Schedules are approximate only and are prepared for the comparison of bids, all work and materials are subject to measurement by the Engineer. Measurement of work performed by the Contractor on Bid items with unit prices other than "lump sum" will be for the actual quantities of work performed and accepted, or material furnished in accordance with the Contract. In the case of lump sum bid items, the Engineer will verify that all of the work represented by the bid item has been completed.

01019.2.5 VARIATIONS IN QUANTITIES OF WORK

The scheduled quantities of work to be done and materials to be furnished may each be increased, decreased, or omitted at the Owner's discretion.

01019.2.6 MEASUREMENT BY LUMP SUM

The term "Lump Sum" when used as a unit of measurement for a specific improvement or separate component of a unit shall include all work necessary to complete that entire unit, including all necessary fittings and accessories delineated by the pay limits as shown on the Drawings. If no pay limits are shown on the Drawings, then the improvement shall include all fittings and accessories within 5-feet of the item.

01019.2.7 MEASUREMENT BY LINEAL FOOT

All work measured by the lineal foot shall be measured parallel to the centerline. For water and gas piping, no deduction will be made for valve, fittings or carrier pipe. For sewer collection piping, measurement shall be to the inside surface of connecting manholes. Piping connected to structures, except headwalls, shall be measured to a point five (5) feet outside of that structure, unless indicated otherwise on the Drawings.

A station, when used as a unit of measurement, will be 100 lineal feet.

Items measured by the lineal foot; such as pipe culverts, guardrail, under-drains, etc., will be measured parallel to the base or foundations upon which structures are placed.

The thickness of plates and galvanized sheet used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing will be specified and measured in decimal fractions of inches.

01019.2.8 MEASUREMENT BY AREA

Area computations will be made from actual horizontal and transverse measurements made on the site of the work.

Structures will be measured to the neat lines shown on the plans or as altered to fit site conditions.

Lumber will be measured by the thousand feet board measure (M.F.B.M.) actually incorporated in the structure. Measurement will be based on nominal widths and thickness and the extreme length of each piece.

01019.2.9 MEASUREMENT BY VOLUME

In computing volumes of excavation, the average end area method will be used unless the Engineer and Contractor agree, in writing, to an alternate method.

Materials to be measured by volume or by load count shall be hauled in approved vehicles and measured at the point of delivery. Vehicles for this purpose may be of any size or type, provided the body is shaped so the actual volume may be readily and accurately determined.

When liquid bituminous materials are measured by the gallon or ton, volumes will be measured at 60° F, or will be corrected to the volume of 60 degrees F, using ASTM D 1250 for asphalt or ASTM D 633 for tars. When bituminous materials are shipped by truck or transport, net certified weights or volume subject to correction for loss or foaming, may be used for computing quantities.

01019.2.10 MEASUREMENT BY WEIGHT

The term "ton" will mean the short ton of 2,000 pounds avoirdupois.

When measurement units require weighing materials for payment, the Contractor shall be responsible for providing weight measurement from commercial certified scales or from scales provided at the job site which are certified in the state wherein the work is located.

Cement will be measured by the ton or hundredweight.

01019.2.11 CONVERSION OF WEIGHT TO VOLUME

When requested by the Contractor and approved by the Engineer in writing, materials specified to be measured by the cubic yard may first be weighed and the weight converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and agreed to by the Contractor before this method of measurement of quantities is used.

01019.2.12 SPECIFIC MANUFACTURED ITEMS

When standard manufactured items are specified; such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gauge, unit, weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerance in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

01019.2.13 RENTAL EQUIPMENT

Rental of equipment will be measured in hours of actual working time and necessary traveling time of the equipment within the limits of the project. If equipment is ordered held on the project on a standby basis by the Engineer, the agreed rental rate, minus the labor and fuel costs, will be paid.

01019.2.14 MEASUREMENT BY EACH

All work measured by each shall be an an individual or single unit.

01019.3 PAYMENT**01019.3.1 SCOPE OF PAYMENT**

The Contractor shall receive and accept compensation provided in the Contract as full payment for:

- Furnishing all materials, labor, equipment, tools, transportation and incidentals required for completion of work.
- All loss or damage due to the nature of the work, action of the elements and unforeseen difficulties until final acceptance by the Engineer, subject to the provisions of the General Conditions.
- All costs arising from any infringement of a patent, trademark or copyright.
- Bids shall include all sales tax and all other applicable fees.

01019.3.2 NON-PAYMENT

No payment will be made for:

- Work which is in excess of that described in the Contract Documents.

- Removal and replacement of defective work.
- Loss of anticipated profits.

01019.3.3 LUMP SUM

The term "lump sum", when used as a unit for payment, shall include all work required to complete the item, including all necessary fittings and accessories, as described in the Bid Schedule.

01019.3.4 FULL PAYMENT

The Contractor shall receive and accept compensation provided for in the Contract as full payment for furnishing all materials and for performing all work under the Contract in a complete and acceptable manner and for all risk, loss, damage or expense of whatever character arising out of the nature of the work or the execution thereof.

01019.3.5 VARIATION IN QUANTITY OF WORK

The Owner reserves the right to make variations in quantities by adding to, or deleting from, quantities listed in the bid schedule in order to match the total bid with the money available in the budget.

01030.1 DESCRIPTION

This section covers project meetings including the pre-construction meeting and other progress and/or work coordination meetings conducted to provide communication and awareness to all parties associated with the Contract.

01030.2 PRE-CONSTRUCTION CONFERENCE

Prior to the commencement of work at the site, a pre-construction conference will be held at a mutually agreed time and place to be arranged by the Engineer. The Engineer shall also provide notification to all parties expected to attend the meeting. Attendees will include the following:

- Engineer
- Project Inspector
- Owner/Owner's Representative
- Contractor/Contractor's Representative/ Subcontractors as appropriate
- Governmental Representatives as appropriate (State, County, Municipal, etc.)
- Manufacturer/Supplier Representatives/Adjoining Contractors, as appropriate.
- Utility Service Representatives as appropriate.

01030.2.1 Unless previously submitted to the Engineer, the Contractor shall bring to the conference one copy each of the following:

- Contract construction schedule in accordance with the General Conditions.
- Procurement schedule of major equipment and materials and items requiring long lead-time.
- Shop Drawings, samples or substitution proposals for items proposed as substitutions or "or equal" items.
- Schedule of work that includes the anticipated monthly payment amounts during the contract.
- A Schedule of Values of work to be paid for as lump sum items where partial payment is anticipated.

01030.2.2 The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The agenda may include but not be limited to the following items:

- Contractor's Work Schedule.
- Transmittal, review, distribution and approval of Contractor's submittals.
- Processing of applications for payment.
- Maintaining records and documents.
- Critical work sequencing.
- Field decisions and Change Orders.
- Use of project site, office and storage areas, security, housekeeping, and Owner's needs.
- Major equipment deliveries and priorities.
- Interpretation of Drawings and Specifications.
- Contractor's responsibilities for safety, first-aid and sanitation.

01030.2.3 The Engineer will preside at the pre-construction conference and will arrange for keeping minutes and distributing them to all attendees to the meeting.

01030.3 PROGRESS/COORDINATION MEETINGS

01030.3.1 The Contractor shall conduct regular on-site progress and coordination meetings at least weekly and at other times as requested by Engineer or as required by progress of the work. The

Contractor, Engineer, and all Subcontractors active on the site shall be represented at each meeting. The Contractor may, at its discretion, request attendance by representatives of its suppliers, manufacturers, and other Subcontractors. The Contractor shall be responsible for providing written notification to those deemed necessary for attendance at least 36 hours prior to the time set for the meeting.

- 01030.3.2 The Contractor shall preside at the meetings and maintain a file of minutes of the proceedings. The purpose of the meetings will be to review the progress of the work, maintain coordination of effort, discuss changes in scheduling, and resolve other problems which may develop.

01090.1 DESCRIPTION

Wherever in these Specifications references are made to the standards, specifications, or other published data of the various national, regional, or local organizations, such organizations may be referred to by their acronyms or abbreviations only. As a guide to the user of these Specifications, the following acronyms or abbreviations, which may appear herein, shall have the meanings indicated below.

01090.1.1 DEFINITIONS OF ABBREVIATIONS AND ACRONYMS

AAR	Association of American Railroads
AASHTO	American Association of the State Highway and Transportation Officials
ACI	American Concrete Institute
ADC	Air Diffusion Council
AGA	American Gas Association
AGC	Associated General Contractors
AGMA	American Gear Manufacturers Association
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute, Inc.
APWA	American Public Works Association
ARI	Air Conditioning and Refrigeration Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASQC	American Society of Quality Control
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BLM	Bureau of Land Management (U.S. Department of Interior)
CDA	Copper Development Association
CEMA	Conveyor Equipment Manufacturer's Association
CGA	Compressed Gas Association
CFR	Code of Federal Regulations
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturer's Institute
CMA	Concrete Masonry Association
CS	Commercial Standard of NBS (U.S. Dept. of Commerce)
CTI	Cooling Tower Institute
DIP	Ductile Iron Pipe
EIA	Electronic Industries Association
EPA	U. S. Environmental Protection Agency
ETL	Electrical Test Laboratories
FEMA	Federal Emergency Management Administration
FERC	Federal Energy Regulatory Commission
FS	Forest Service (U.S. Department of Agriculture)
FWS	Fish and Wildlife Service
GI	Galvanized Iron
IAPMO	International Association of Plumbing and Mechanical Officials
ICBO	International Conference of Building Officials

ID	Inside Diameter
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IMC	International Mechanical Code
IME	Institute of Makers of Explosives
IPC	International Plumbing Code
ISA	Instrument Society of America
ISO	International Organization for Standardization
MBMA	Metal Building Manufacturer's Association
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFGC	National Fuel Gas Code
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NRCS	Natural Resources Conservation Service (U.S. Department of Agriculture) (formerly SCS)
NSF	National Sanitation Foundation
OD	Outside Diameter
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PDI	Plumbing and Drainage Institute
PE	Polyethylene
PVC	Polyvinyl Chloride
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
SSPWC	Standard Specification for Public Works Construction
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code
UPRR	Union Pacific Railroad
USDARD	Rural Development (U.S. Department of Agriculture) (formerly Farmers Home Administration)
WCRSI	Western Concrete Reinforcing Steel Institute
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association

01090.2 REFERENCED WORKS, CODES AND STANDARDS

Whenever references to specifications, codes, standards and other publications are made to these Specifications, the following rules shall apply:

01090.2.1 TITLES OF SECTIONS AND PARAGRAPHS

Titles of sections and/or paragraphs shown in these Specifications are for convenience of reference only, and do not form a part of the Specification.

01090.2.2 APPLICABLE PUBLICATIONS

Whenever references in these specifications are made to published specifications, codes, standards, or other requirements, it shall be understood that unless a date is specified, only the latest edition

of these specifications, codes, and/or standards which have been published as of the date that the work is advertised for bids, shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the Drawings shall be waived because of any provision of, or omission from, said standards or requirements.

01090.2.3 SPECIALISTS AND SPECIAL ASSIGNMENTS

In certain instances, specification text requires (or implies) that specific work is to be assigned to specialists or expert entities, who must be engaged for the performance of that work. Such direction shall be recognized as special requirements and is not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of work is recognized as "expert" and qualified for the assignment of the work. Nevertheless, the final responsibility for fulfilling this assignment remains with the Contractor.

01090.2.4 BUILDING CODES

Reference herein to "Building Code" shall mean the Uniform Building Code issued by the International Conference of Building Officials (ICBO). The latest edition of the code as approved and used by the local agency as of the date of award, as adopted by the agency having jurisdiction, shall apply to the work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

01090.2.5 OSHA

01090.2.5.1 OSHA REGULATIONS - References herein to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

01090.2.5.2 OSHA STANDARDS - References herein to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards of the U.S. Code of Federal Regulations, including all changes and amendments thereto.

01090.2.6 DOT STANDARDS/SPECIFICATIONS

References to "State DOT Specifications" or "State DOT Requirements" shall mean the Specifications for Excavation on State Highway Right-of-Way and/or Standard Specifications for Road and Bridge Construction, including all amendments thereto, issued by the State agency responsible for highways wherein the Contract is located and any other written requirements or provisions issued by that agency which are contained in these Contract Documents.

01090.2.7 FEDERAL PIPELINE SAFETY STANDARDS

Reference to "Federal Pipeline Safety Standards" shall mean Title 29, Parts 191 and 192, Federal Pipeline Safety Minimum Standards, U.S. Code of Federal Regulations including all changes and amendments thereto.

01090.2.8 STATE GAS PIPELINE SAFETY STANDARDS

References to "State Gas Pipeline Safety Standards" shall mean the appropriate section/s of the legal code or regulations adopted in the State wherein the work is located, including all changes and amendments thereto.

01090.3 STANDARDS IMPOSED BY OTHER AGENCIES OR ORGANIZATIONS**01090.3.1 PROPERTY BELONGING TO OTHER AGENCIES OR ORGANIZATIONS**

Construction may occur on property owned or administered by agencies or organizations other than the Owner, such as federal and/or state departments of transportation, the U. S. Forest Service, the U. S. Bureau of Land Management, the U.S. Fish and Wildlife, counties, canal companies, irrigation companies, utility companies, other federal and state agencies, municipal governments, etc. Work which is to take place on such property may be required to be in accordance with special construction requirements of that agency or organization as well as these specifications.

01090.3.2 ADDITIONAL INFORMATION AND SPECIFICATIONS

Information will be provided on the plans to indicate areas of the Work which fall on property owned or administered by agencies and organizations other than the Owner. Specifications from agencies which are affected by the work will be provided in the Appendix to the Contract Documents. Those specifications provided in the Appendix shall be considered part of the Contract Documents and the Contractor shall include sufficient compensation in its bid to cover the work required for compliance thereto.

01090.4 CONFLICTS

In case of conflict between codes, reference standards, Drawings and the other Contract Document, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the Engineer for clarification and directions prior to ordering or providing any materials or labor required therefrom. The Contractor shall assume the most stringent requirements apply when preparing bids for this Contract.

01200.1 DESCRIPTION

The purpose of this section is to clarify certain aspects of the Project and the Contract that must be taken into consideration and completed before final acceptance of the Work can be given. These items include cleanup, demonstration of acceptable performance of equipment and facilities furnished and installed, submittals, payment for all work completed, issuance of final acceptance documentation, accepted repair and restoration of work and materials found defective during the warranty period. Specific instructions are provided herein for completion of the Work in such a manner that it will be fully acceptable and that the Contractor will be eligible for receipt of final payment.

01200.1.1 RELATED WORK AND REFERENCED SECTIONS

Not used.

01200.1.2 SUBMITTALS

Section 01300 - Submittals
See paragraph 01200.3.5 below.

01200.1.3 DEFINITIONS

Not used.

01200.2 MATERIALS

Not used.

01200.3 CONSTRUCTION REQUIREMENTS**01200.3.1 CLEANUP**

The Owner will not give final acceptance of the Work until the Contractor has satisfactorily complied with the finishing and cleanup requirements contained in these Contract Documents and with any applicable local regulations. The Contractor shall accomplish the cleanup operations so as to leave the work site in an orderly, acceptable, and presentable condition.

01200.3.2 REPAIR AND RESTORATION

All major and minor damage to improvements and finished surfaces resulting from the Contractor's performance of the Work, whether to materials and equipment located on the project site or to those constructed under this Contract, shall be repaired to an original, or like-new, condition before final acceptance will be provided by the Engineer and Owner. Where damage to surfaces or materials can not be sufficiently repaired or restored, in the opinion of the Engineer, the Contractor may be required to replace the entire surface covering or structural member to achieve an original or like-new condition of the surface or material.

01200.3.3 TESTING

All performance and operational testing of facilities and equipment required by the Contract Documents, together with any required supportive documentation, shall be completed by the Contractor and approved by the Engineer prior to final acceptance of the Work.

01200.3.4 ACCEPTANCE FROM PROPERTY OWNER

The Contractor shall obtain a written release from each property owner on whose property work has been required by these Contract Documents. Such release shall indicate the property Owner's approval of the restoration and/or replacement of all disturbed improvements, surfaces and structures. Any request made to the Contractor by a private property owner, and determined to be unreasonable in the opinion of the Engineer, may be waived by the Owner.

01200.3.5 SUBMITTAL OF MANUFACTURER'S DOCUMENTATION

All guarantees and warranties, operation and maintenance manuals or brochures, or other materials furnished to the Contractor by the manufacturer for any equipment or material used for the Work shall be delivered to the Owner in protective 3-ring binders. Retainage held to the Contractor in accordance with the General Conditions of the Contract Documents will not be released until such documentation is submitted. See Section 01300 for more detail regarding O&M manuals.

01200.3.6 FINAL ACCEPTANCE

01200.3.6.1 CONTRACTOR'S STATEMENT OF COMPLETION - When the Contractor has completed the Work under this contract, including all of the Contractor's testing and clean-up, the Contractor shall inform the Engineer in writing that the Work has been completed and request a final inspection by the Engineer. The Engineer will then conduct a final inspection with the Owner and representatives of the pertinent funding and regulatory agencies. If items are found by the Engineer to be incomplete or not in compliance with the contract requirements, the Engineer will inform the Contractor of such items. After the Contractor has completed these items, the procedure shall then be the same as described above for the Contractor's statement of completion and request a final inspection.

01200.3.6.2 NOTICE OF FINAL ACCEPTANCE - After the Engineer has determined that all work required under the Contract Documents has been completed and that all of the considerations specified herein above are satisfactorily concluded, the Engineer will recommend to the Owner, in writing, that final acceptance of the entire Work under this contract be made as of the date of the Engineer's final inspection. The Owner and Engineer will then indicate formal approval and acceptance of the Work by issuing the "Notice of Final Acceptance" form.

01200.3.6.3 NO PARTIAL ACCEPTANCE - Unless otherwise required by Special Provisions, partial acceptance of any portion of the Work will not be made. While Substantial Completion notice can be issued in accordance with the General Conditions to allow use of completed work for its intended purpose, no acceptance other than the final acceptance of all completed work will be made. No inspection or approval or Notice of Substantial Completion pertaining to specific parts of the work shall be construed as final acceptance of any part until written final acceptance of all work is issued.

01200.4 METHOD OF MEASUREMENT

Not used.

01200.5 BASIS OF PAYMENT

Not used.

01300.1 DESCRIPTION

This section covers procedures to be followed by the Contractor when providing information to the Owner and/or Engineer to obtain approval of materials, equipment, procedures, etc. described in the Specifications and Drawings.

01300.2 SHOP DRAWINGS AND MATERIALS SUBMITTALS**01300.2.1 NUMBER OF COPIES OF SUBMITTALS**

The Contractor shall furnish six (6) copies of each shop drawing and pertinent materials information sheet to the Engineer for review. A full set of submittals shall be provided to the Engineer seven (7) days prior to commencement of construction activity. Following review and approval, two copies shall be returned to the Contractor for his records, two shall be retained by the Engineer for inspection and verification purposes, and two shall go to the Owner as working and archival records.

01300.2.2 SHOP DRAWINGS

01300.2.2.1 CONTRACTOR REVIEW - The Contractor's shop drawing submittals shall be reviewed by a qualified representative of the Contractor, prior to submission to the Engineer. Such review shall be made to ensure the accuracy and compliance with the technical requirements and performance described and illustrated in the Drawings and Specifications.

01300.2.2.2 CONTENT - Shop drawings shall include drawings, pictures and sketches with sufficient details and explanations to reflect the Contractor's interpretations of components and required configurations not shown on the drawings, so that a documented record of such can be approved for incorporation in the Work. These drawings shall be accurate, distinct, and complete and shall contain all required information, including satisfactory identification of items and unit assemblies in relation to the Drawings and/or Specifications.

01300.2.2.3 TIMELY SUBMITTAL - Shop drawings shall be submitted sufficiently in advance to allow the Engineer not less than ten regular working days prior to manufacturing for examining the drawings.

01300.2.2.4 ENGINEER APPROVAL - When the shop drawings are approved by the Engineer, two sets of copies will be returned to the Contractor marked "Approved", "Revise as Noted", "Rejected", "Approved Except as Noted", or similar notification. If changes or corrections are necessary, one set will be returned to the Contractor with such changes or corrections indicated by a brief statement, and the Contractor shall correct and resubmit the drawings, in triplicate, to the Engineer.

Fabrication work shall not commence until the Engineer has reviewed the pertinent shop drawing/s and returned copies to the Contractor marked either "Approved" or "Approved - Except as Noted". Corrections indicated on such submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis of claims for extra work.

Approval of shop drawings will not be required for reinforcing steel that is detailed by the Contractor in accordance with the Plans and Specifications. Any change from the Plans and Specifications made by the Contractor in any aspect of the Work shall be approved by the Engineer in a written Change Order prior to any work being altered from that already approved for construction.

001300.2.3 MATERIALS INFORMATION SUBMITTALS

In keeping with 01300.2.1 above, the Contractor shall assemble and submit six (6) original copies of each manufacturer's catalog cuts and materials information sheets pertaining to materials and equipment to be furnished and installed in the Work. These submittals shall be enclosed in 3-ring binders. Failure to submit all materials information may result in the Contractor's partial payments to be withheld until submittals are complete. Photocopies of the catalog cuts and information sheets will not be acceptable as submittals without prior authorization from Engineer.

01300.2.4 CONTRACTOR LIABILITY

The Contractor shall assume all responsibility and risk for any re-work or other costs resulting from errors in Contractor submittals. The Contractor shall be responsible for showing accurate dimensions and details of connections required to ensure the function of the equipment and/or component of the Work being illustrated.

01300.3 SAMPLES**01300.3.1 NUMBER OF SUBMITTALS**

Whenever requested by the Engineer, the Contractor shall submit at least one sample of each item or material indicated in the Specifications to the Engineer for inspection and acceptance and do so at no additional cost to the owner.

01300.3.2 TIMELY AND ORDERLY SUBMITTAL

Samples shall be submitted sufficiently in advance of placement of orders that the Engineer shall have not less than ten regular working days for examining and testing the material for acceptance prior to delivery to the job site. Samples shall be submitted in an orderly sequence and appropriately identified so that dependent materials or equipment can be assembled and reviewed without causing delays in the work or mistakes in their identity.

01300.3.3 SELECTION OF COLORS AND TEXTURES

Unless otherwise specified, the Owner and the Engineer will select all colors and textures of specified items from the manufacturer's standard colors and standard materials, products, or equipment lines.

01300.4 OPERATIONS AND MAINTENANCE MANUALS**01300.4.1 STRUCTURE OF OPERATIONS AND MAINTENANCE MANUALS**

The Contractor shall furnish to the owner four (4) identical sets of Operations and Maintenance manuals. Each set shall consist of one or more volumes, each of which shall be bound in a standard size, 3-ring, loose-leaf, vinyl plastic, hard cover binder suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches. A table of contents shall be provided which indicates all equipment in the Operations and Maintenance manuals.

01300.4.2 CONTENTS

The Contractor shall include in the Operations and Maintenance Manuals the following information for each item of mechanical, electrical, and instrumentation equipment:

- Care and maintenance of all finished exposed surfaces.

- Complete operating instructions, including location of controls, special tools or other equipment required, related instrumentation, and other equipment needed for operation.
- Preventive maintenance procedures and schedules.
- Complete parts lists, by generic title, identification number, and catalog number, complete, with exploded views of each assembly.
- Disassembly and reassembly instructions.
- Name and location of nearest supplier and spare parts warehouse.
- Name and location of manufacturer.
- Recommended start-up, testing and troubleshooting procedures.
- Prints of the record drawings, including diagrams and schematics, as required under the electrical and instrumentation portions of these specifications.

01300.4.3 SCHEDULE OF DELIVERY

Operations and Maintenance manuals shall be submitted in final form to the owner before seventy-five (75) percent of the Work is completed. Any discrepancies found by the owner and Engineer in the Operations and Maintenance manuals shall be corrected by the Contractor prior to final acceptance of the project.

01300.5 SCHEDULE OF VALUES

At the time of the pre-construction conference, the Contractor shall submit a Schedule of Values of the Work measured as lump sum bid items. On the Schedule, those items shall be subdivided into component parts in sufficient detail as to form a basis for determining progress payments during construction. Quantities, and/or prices, shown on the Schedule shall equal the total contract price for each lump sum item. Information provided on the Schedule will be reviewed and approved by the Engineer when found acceptable. That information will then be incorporated into the data used for preparing the Application for Payment by the Engineer.

01300.6 CONTRACT CONSTRUCTION SCHEDULE

A construction schedule, prepared in accordance with requirements of the General Conditions, shall be submitted to the Engineer at the pre-construction conference. Unless required otherwise in Special Provisions, such schedule shall show the anticipated time of completion, approximate start dates of identifiable segments of the Work, and anticipated value of the work expected to be completed in monthly time periods within the contract period.

01300.7 PROCUREMENT SCHEDULE

At the time of the pre-construction meeting (see Section 01030), the Contractor shall submit a procurement schedule to the Engineer. This plan shall include all equipment and materials required for the Work included in the Contract that are not readily available and will require off-site manufacture and lead time which can affect the progress of the Work. The plan shall show at least the following information:

- Equipment/Material Name
- Anticipated amount of time for ordering, manufacturing, and shipping to Work site.
- Anticipated dates for ordering, receiving and installing.

01300.8 CONSTRUCTION PHOTOGRAPHY RECORDS

When required in the Contract Documents and prior to commencement of any of the Work, the Contractor shall prepare colored CD photography records of all areas of the Contract work site and provide copies of such records to the Engineer. Such records shall become the property of the owner and may be used for determining the condition of work site/s and degree of restoration required for completion of the Work (see also Section 2000).

01400.1 DESCRIPTION

This section covers quality control of all work and activities on the part of the Owner, the Engineer, and the Contractor, to ensure compliance with these Specifications and the requirements of the Contract.

01400.2 ASSIGNMENT OF RESPONSIBILITY**01400.2.1 THE CONTRACTOR**

The Contractor has primary responsibility for ensurance of quality control of the Work provided under the Contract. Therefore, any omission or failure on the part of the Engineer to notify the Contractor of, or to condemn defective work and/or materials at the time of construction shall not be taken as acceptance of the work or materials, and the Contractor will be required to correct any defective work or materials prior to final acceptance.

01400.2.2 THE OWNER AND ENGINEER

The Engineer will endeavor to locate any errors or defective materials or workmanship, and call them to the attention of the Contractor prior to subsequent work being performed. However, the Engineer is under no obligation to do so, and neither the Owner, nor the Engineer shall be held liable for errors, or defective material, or defective workmanship performed by the Contractor and not discovered by the Engineer prior to subsequent work being performed.

01400.2.3 CORRECTIONS

Prior to execution of the Agreement, the Engineer may correct errors and omissions to these Contract Documents by issuing Addenda. After execution of the Agreement, correction of errors, omissions or other changes necessitated shall be made in accordance with the General Conditions (Section 00700).

01400.3 QUALITY OF MATERIALS**01400.3.1 COMPLIANCE WITH SPECIFICATIONS**

All materials and equipment incorporated in the Work shall be of new manufacture and shall be of the grade and quality described by these Specifications and the Special Provisions.

01400.3.2 SPECIFIED MATERIALS

Where a specific brand or manufacturer's equipment, model, system, or etc. is specified in these Specifications, no intention is made to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance.

01400.3.3 SUBSTITUTION OF MATERIALS

The Engineer, in accordance with the General Conditions (Section 00700.8), may allow substitution of equipment or materials. The Owner reserves the right to reject substitutions if, in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

01400.4 QUALITY OF WORK

All workmanship incorporated in the Work covered by the Contract is to be of the grade and quality described by these Specifications and the Special Provisions.

01400.5 OBSERVATION01400.5.1 **AUTHORITY AND DUTIES OF OBSERVERS**

01400.5.1.1 **AUTHORITY** - Observers representing the Engineer are authorized to observe all work performed and all materials furnished and to reject defective material and any work that is improperly performed, subject to the final decision of the Engineer. This authority extends to all or any part of the Work, including the preparation, fabrication, or manufacture of any materials or equipment to be used for completion of the Work. The Observers is not authorized to alter or waive the provisions of these Specifications or other provisions of the Contract Documents. The Engineer may delegate additional authority to the Observers when such action is determined to be necessary.

01400.5.1.2 **DUTIES** - Observers keep the Engineer informed as to the progress of the Work and the manner in which it is performed. Observers are also assigned to call the Contractor's attention to any observed nonconformance with the Contract Documents. The Observer will not act as foreman for the Contractor.

01400.5.2 **OBSERVATION OF MATERIALS**

01400.5.2.1 **TESTING** - In accordance with the Contract Documents and at the option of the Engineer, materials to be supplied under this contract will be tested and/or inspected either at their place of origin or at the site of the Work. The Contractor shall give the Engineer written notification well in advance of actual readiness of materials to be tested and/or inspected at the point of origin. Satisfactory tests and inspections at the point of origin shall not be construed as a final acceptance of the material nor shall it preclude re-testing or re-inspection at the site of the Work.

01400.5.2.2 **SAMPLES** - The Contractor shall furnish such samples of materials as are requested by the Engineer, without charge. No material shall be incorporated into the Work until the Engineer has approved it (see Section 01300).

01400.5.3 **CONTRACTOR LIABILITY**

The observation of the Work shall not relieve the Contractor of any of its obligations to fulfill its contract as herein provided, and unsuitable materials may be rejected notwithstanding that such unsatisfactory performance may have been overlooked and accepted or estimated for payment.

01500.1 DESCRIPTION

Covers requirements for aptness, competency, quality, and quantity in the labor, equipment, tools, and materials supplied by the Contractor for execution of the Work.

01500.2 REQUIREMENTS

In order to bring the Work to completion in the manner and on the time schedule required by the Contract Documents, the Contractor shall provide sufficient labor and equipment with adequate training and capability as follows:

- The Contractor shall employ sufficient labor and equipment with adequate training and capability for executing the Work to full completion in the manner and time required by these Specifications.
- All workers shall have sufficient skill and experience to perform properly the work assigned to them. Workers engaged in special work or skilled work shall have appropriate training and sufficient experience in such work, in the opinion of the Engineer, to perform all work properly and satisfactorily.
- Any person employed by the Contractor or by any Subcontractor who, in the opinion of the Engineer, does not perform their work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the Engineer, be removed forthwith by the Contractor or Subcontractor employing such person. Such person(s) shall not be employed again in any portion of the Work without the approval of the Engineer. When such action is considered, and if requested by that employee, a hearing attended by the employee, Engineer, and Contractor shall be conducted before final dismissal action is taken.
- Should the Contractor fail to remove such person or persons as required above or fail to furnish suitable and sufficient personnel for the proper execution of the Work, the Engineer may suspend the Work by written notice until such order is complied with.
- All equipment, which is proposed to be used on the Work, shall be of sufficient size and in such mechanical condition, in the opinion of the Engineer, as to produce a satisfactory quality of Work. Equipment used on any portion of the Work shall be fitted with appropriate protective devices in accordance with OSHA and other applicable safety regulations such that no injury to employees, the Work, or to adjacent property will result from its use.
- When the specific methods and equipment to be used by the Contractor in accomplishing the Work are not described in the Contract Documents, the Contractor is free to use any methods or equipment that will accomplish the Work in conformity with the requirements of this Contract.

01510.1 DESCRIPTION

This section covers measures and instructions for prevention of damage to existing structures and utilities, whether above ground or underground, during execution of the Work of the Contract.

01510.2 PROTECTION OF EXISTING UTILITIES**01510.2.1 INTEGRITY OF UTILITIES**

The Contractor shall be responsible for safeguarding and maintaining the integrity of all conflicting utilities. This responsibility includes securing the assistance of available utility location services in the area in which the Work is being performed. The Engineer has attempted to show the location of all utilities anticipated to conflict with the Work. However, when a conflicting utility line is discovered that was not shown on the plans, the Contractor shall contact the utility's owner and notify the Engineer immediately for resolution of the conflict. When realignment or relocation of the Work, or relocation of the conflicting utility is deemed necessary, the Engineer shall give direction in writing for the Contractor to proceed. Work resulting from such direction may be treated as a changed condition, and appropriate authorization and payment will be made in accordance with the General Conditions.

01510.2.2 LOCATING UTILITIES

It shall be the responsibility of the Contractor to locate and expose or identify all existing utilities, both underground and overhead, for the purpose of preventing damage to them. The Contractor shall notify all concerned utility offices at least 48 hours in advance of construction operations in which a utility agency's facilities may be involved. This shall include, but not be limited to, irrigation water, culinary water, telephone, gas, and electric.

01510.2.3 CHANGES TO UTILITIES

The Contractor shall be responsible for any and all changes to, or re-connections to, public utility facilities encountered or interrupted during execution of the Work, and all costs related thereto shall be borne by the Contractor. The Contractor shall negotiate with, and pay, the respective utility agency for work it must do in connection with moving, repairing, or restoring its utility(s). The Contractor shall further make all necessary notifications, scheduling, coordination, and management of details related to any such interference. The potential or projected cost of any public utility interference shall be included in the Contractor's price covering the major Contract Item to which the interference or changes are attributable.

01510.2.4 MAINTENANCE OF SERVICE

01510.2.4.1 CONTINUOUS SERVICE - Unless otherwise required in the Contract Documents, all utilities, both underground and overhead, shall be maintained in continuous service throughout the entire contract period. The Contractor shall be responsible and liable for any damages to or interruption of service caused by the construction.

01510.2.4.2 ACCIDENTAL INTERRUPTION OF SERVICE - In the event of interruption of other utility services as a result of accidental breakage, the Contractor shall promptly notify the appropriate responsible authority. The Contractor shall then cooperate with that authority in restoration of service as soon as possible, and shall bear all cost of repair. In no case shall interruption of any water or other utility service be allowed outside working hours unless the Engineer has issued prior authorization. When changeover of service connections to new utility lines becomes necessary, interruptions of individual services for periods of up to 8 hours will be allowed providing 24 hour advance notice has been given to affected users.

01510.2.4.3 TEMPORARY INTERRUPTION AND RELOCATION - If the Contractor desires to temporarily or permanently relocate or shut down any utility or appurtenance, the Contractor shall make the necessary arrangements and agreements with the owner or operator of the respective utility and shall be completely responsible for all costs concerned with the relocation or shutdown and reconstruction. Shutdown and relocation and/or reconstruction shall be subject to inspection and approval by the Engineer and the owner of the utility.

01510.3 PROTECTION OF PROPERTY AND EXISTING STRUCTURES

01510.3.1 REMOVAL OR RELOCATION OF PROPERTY - All property removed or relocated by the Work shall be reconstructed in its original or new location as soon as possible. Restoration of existing property or facilities shall be to a condition as good or better than its original condition.

01510.3.2 DAMAGE TO PROPERTY - All property damaged by the Contractor, whether inside or outside the limits of easements provided by the Owner, shall be the responsibility of the Contractor. All such damages shall be repaired with like material and restored to its original condition, or better. Such repair or restoration shall be accomplished at the Contractor's expense without additional compensation from the Owner.

01510.4 PROTECTION OF PAVED SURFACES

To avoid unnecessary damage to paved surfaces, tracked equipment shall use rubber cleats or paving pads when operating on or crossing all existing paved surfaces unless authorized otherwise in writing by the Engineer.

01510.5 RIGHTS-OF-WAY AND EASEMENTS

01510.5.1 MINIMAL DISTURBANCE OF RIGHTS-OF-WAY - When construction easements have been obtained by the Owner, the Contractor shall take appropriate measures to minimize disturbances to surface improvements within the easements. The Contractor shall obtain a signed release from each property owner, approving restoration work in the construction easements across its respective property/s.

01510.5.2 CONSTRUCTION AREAS - The Contractor shall confine construction operations to the area within the dedicated rights-of-way for public thoroughfares, or within areas for which construction easements have been obtained, unless the Contractor has made separate special agreements with the affected property owners in advance.

01510.5.3 PROPERTY OWNER NOTIFICATION - The Contractor shall give at least 48 hours advance notification of commencement of construction to property owners having land on which construction will take place. During all construction operations, the Contractor shall construct and maintain such facilities as may be required to provide access by all property owners to their property. No one shall be cut off from access to their property for a period exceeding eight (8) hours unless the Contractor has made special arrangements with the affected persons. The Contractor shall grade all disturbed surfaces required for motor vehicle traffic at least daily unless directed otherwise in the Contract Documents or in writing by the Engineer.

01520.1 DESCRIPTION

This Section includes requirements that shall be followed by the Contractor, to protect the environment, while performing work under this contract. The Contractor shall also comply with any applicable additional requirements made by federal, state, or local government agencies.

01520.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 00700 – General Conditions, paragraph 32 (for RDA funded projects)

01520.1.2 SUBMITTALS

Section 01300 – Submittals.

01520.1.3 DEFINITIONS

Not used.

01520.2 MATERIALS

Not used.

01520.3 CONSTRUCTION REQUIREMENTS**01520.3.1 EXPLOSIVES AND BLASTING**

The use of explosives on the work will not be permitted unless approved otherwise in the Contract Documents or in writing by the Engineer.

01520.3.2 DUST ABATEMENT

01520.3.2.1 CONTROL MEASURES - The Contractor shall furnish all labor, equipment, water and means required to provide effective dust control and abatement measures. Control measures shall be applied as often as necessary and wherever directed in writing by the Engineer, to prevent construction operations from producing dust in amounts that may be damaging to property, vegetation, or animals, or detrimental to persons within reasonable proximity of the work site.

01520.3.2.2 HAUL ROUTES AND WORK SITES - The Contractor shall identify haul routes or material handling areas, outside of the Work site, whereon dust may be generated, and shall exercise appropriate measures to abate any dust problem caused by its operation. Such dust abatement measures shall be taken immediately when observed or when required in writing by the Engineer.

01520.3.3 STORM AND GROUND WATER

01520.3.3.1 PERMITS REQUIRED - If a storm water NPDES permit is required, the Contractor is responsible to obtain such permit and comply with the conditions thereof.

01520.3.3.2 CONTROL MEASURES - The Contractor shall provide and maintain, at all times during construction, ample means and devices to promptly remove all water entering the Work, whether the water is surface or ground water. Water removed by the Contractor shall be directed into ponds or areas separated from live streams or drainage ways, to keep sediment from entering live water.

- 01520.3.3.3 DRAINAGE PATTERNS - In excavation, fill, and grading operations, the Contractor shall take care, to disturb the existing drainage pattern as little as possible. Particular care shall be taken not to direct drainage water onto private property or into streets or drainage ways inadequate for the increased flow.
- 01520.3.3.4 FORDING OF WATERWAYS - Fording of live streams or any body of live water to accomplish the Work shall not be permitted. Mechanized equipment also shall not be operated in live water to accomplish the Work unless authorized in writing by the Engineer, or in the Contract Documents.
- 01520.3.3.5 FILLING OF WATERWAYS - The Engineer will not approve the filling of any ditches, washes, drainage ways, streams, wetlands, or other surface waters by the Contractor to accomplish the Work unless specific instructions are included in the Contract Documents which will provide for how the affected drainages or surface waters are to be treated.
- 01520.3.4 NOISE ABATEMENT
- In or near inhabited areas, particularly residential areas, the Contractor's operations shall be performed in a manner to prevent noise from becoming a nuisance or problem. Particular consideration shall be given to noise generated by repair and service activities during the night hours.
- 01520.3.5 CHEMICALS
- All chemicals and/or petroleum based products used during project construction or furnished for project shall be handled, applied and disposed of in strict accordance with the printed instructions of the manufacturer and regulations enforced by Federal, State and Local health authorities.
- 01520.3.6 WASTE AND SURPLUS MATERIALS DISPOSAL
- 01520.3.6.1 CLEAN WORK SITE - The Contractor shall keep the work site, haul roads and other areas of use in a neat, clean condition, free from any accumulation of surplus materials. It shall be the responsibility of the Contractor, at its own expense, to remove and legally dispose of all surplus materials resulting from all Work activities performed in accordance with the Contract Documents.
- 01520.3.6.2 SURPLUS MATERIAL - Surplus material includes, but is not limited to, salvaged materials and equipment that otherwise would have been abandoned in place, rocks too large to be used as backfill, wood and other organic or unsuitable materials, trash, rubbish, and waste products of any nature, and any other debris generated by the Work.
- 01520.3.6.3 REGULATORY COMPLIANCE - Disposal of surplus materials shall be accomplished in accordance with all local codes, laws, ordinances, and all applicable safety laws (particularly to the requirements of Part 1926 of the OSHA Safety and Health Standards for Construction) in affect at the approved disposal site. In no case shall it be acceptable for any surplus material to be disposed of in streams, marshes or wetlands.
- 01520.3.6.4 APPROVAL OF DISPOSAL - The Engineer will not approve any disposal operation, which creates an unsightly and/or unsanitary nuisance. The Contractor shall maintain disposal sites in a reasonable condition of appearance during construction. When designated and/or public disposal sites are unavailable, written approval must be obtained from the Engineer to dispose of any surplus materials on any other site. All disposal sites are subject to approval by the Engineer. The Contractor shall secure permission and all permits required for use of any dumpsite not previously arranged and designated by the Owner. The Contractor shall retain copies, and provide copies upon request, of all disposal permits and/or agreements obtained for the Contract Work.

- 01520.3.6.5 **SCHEDULED REMOVAL** - The Contractor shall establish regular intervals of collection and disposal of surplus materials during construction. Stockpiling of surplus materials for later disposal will not be approved or allowed.
- 01520.3.7 **OPEN BURNING**
- Open burning of materials may be allowed only in strict accordance with all regulations in effect for the area at which the burning would be performed, and the Contractor shall obtain any necessary permits from the appropriate governing entity prior to the start of burning. The Contractor shall not allow fire to spread beyond the material intended for burning. No accumulation of residue from burning shall remain on or adjacent to the construction site, without written approval of the Engineer.
- 01520.3.8 **SANITATION**
- 01520.3.8.1 **TOILETS** - The Contractor shall provide fixed or portable chemical toilets for employee use in conformance with the requirements of Part 1926 of the OSHA Standards for Construction and when public toilets are not available or within fifteen (15) minutes walking distance of the Work site.
- 01520.3.8.2 **COLLECTION OF WASTES** - The Contractor shall be responsible for daily collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the Contractor shall be disposed of away from the site in accordance with all laws and regulations pertaining thereto.
- 01520.3.9 **HAZARDOUS MATERIAL**
- 01520.3.9.1 **REGULATORY COMPLIANCE** - Disposition of any hazardous material or toxic or hazardous waste shall be made in accordance with the requirements and regulations administered by the State agency wherein the Work site is located.
- 01520.3.9.2 **ABNORMAL CONDITONS** - Abnormal conditions include, but are not limited to, the following: buried barrels with liquid or solid contents; buried or above ground tanks with liquid contents; obnoxious odors; excessively hot earth; stained and discolored soils; smoke; unidentifiable powders, sludge, pellets; or any other similar condition.
- 01520.3.9.3 **DISCOVERY AND NOTIFICATION** - If any abnormal conditions are encountered during construction, which indicate the presence of a hazardous material, toxic, or hazardous waste, the Contractor shall immediately suspend work in the area of the discovery and notify the Engineer and treat the situation with extreme caution. The Contractor's operation in the area of discovery shall not resume until so directed by the Engineer; however, the Contractor shall continue working in other areas of the project, unless otherwise directed by the Engineer.
- 01520.3.9.4 **DISPOSAL** - When it becomes necessary for the Contractor to dispose of discovered materials, the work may be considered a change and administered in accordance with the General Conditions. Should the disposition of discovered waste material require special procedures or handling by certified personnel, the Contractor will make all such arrangements. When it becomes necessary to obtain permits for transporting or handling discovered material, the Owner will obtain the permits.
- 01520.3.9.5 **SPILLS AND NOTIFICATION** - In the event of spills of petroleum-based products or hazardous wastes by the Contractor, the Contractor shall immediately notify the Engineer. The Contractor shall also notify the appropriate State environmental enforcement agency, unless the spill consists of less than one (1) gallon of petroleum based products. In no case will notification be made later

than 24 hours after the discovery of the spill. In addition, written notification shall also be made within 5 calendar days of the discovery.

01520.3.9.6 COST OF CLEANUP - All costs for cleanup and disposal of hazardous materials due to spills, inappropriate handling, or negligence of the Contractor shall be borne by the Contractor.

01520.3.10 ENVIRONMENTAL COMPLIANCE

01520.3.10.1 REGULATORY COMPLIANCE - The Contractor shall comply with the applicable requirements of the National Historic Preservation Act as it relates to the preservation of ALL environmental resources. Clearance for protection of environmental resources located within the designated Work site is the responsibility of the Owner and such clearance has been obtained for the Contract, unless provided for otherwise in the Contract Documents.

01520.3.10.2 DISCOVERY OF HISTORIC/ARCHEOLOGICAL OBJECTS – The Contractor shall observe the following:

- DISCOVERY AND NOTIFICATION - If a suspected or unsuspected historic, archeological, or paleontological item, feature, or site is encountered, construction operations shall be immediately stopped in the vicinity of the discovery and the Engineer shall be notified of the nature and exact location of the findings. The Contractor shall not damage the discovered objects and shall provide written confirmation of the discovery to the Engineer within two (2) calendar days.
- RESTRICTION OF CONSTRUCTION - Should operations in the vicinity of a discovery be restricted, the Engineer will keep the Contractor informed concerning the status of the restriction. The Contractor should be aware that the time necessary for the Owner to negotiate the handling of the discovered is variable and is dependent on the nature and condition of the circumstances. It is possible that a delay of as much as three weeks in the vicinity of the discovery can be expected. The Engineer will inform the Contractor when the restriction is terminated. Changes required to accommodate delay or Work resulting from the discovery will be authorized in accordance with the General Conditions.

01520.3.11 OPERATIONS OUTSIDE OF THE PROJECT SITE

In the event the Contractor chooses to use any site or means of obtaining resources beyond those provided as part of the Contract, the Contractor shall retain the services of a qualified, certified environmental consultant to produce a research design or plan for obtaining any and all necessary environmental clearances for such use. The Contractor shall provide the plan to the Engineer for review and approval, as required, following which the plan shall be implemented. The Contractor shall submit evidence of environmental clearances and compliance before commencing any activities within the extended use area. At a minimum, clearances will include those listed below. Additional clearances may be required as necessary.

01520.3.11.1 CULTURAL RESOURCES (Archeological and Historic) - Clearance may require consultation with the State Historic Preservation Office.

01520.3.11.2 THREATENED AND ENDANGERED SPECIES - Compliance may require written clearance from the U.S. Fish and Wildlife Service.

01529.3.11.3 FLOOD PLAINS – May require consultation with the Federal Emergency Management Agency (FEMA) or corresponding state agency.

01520.3.11.4 WETLANDS AND OTHER BODIES OF WATER – May require consultation with the Army Corps of Engineers and/or appropriate state agency.

The Contractor is cautioned that obtaining environmental clearances can be costly and time consuming.

01520.4 METHOD OF MEASUREMENT

Not used.

01520.5 BASIS OF PAYMENT

Not used.

01560.1 DESCRIPTION

Construction staking procedures and responsibilities are broadly defined in the General Conditions and specific information is provided in this Section to define those procedures and responsibilities indicated in the General Conditions.

01560.2 QUALITY CONTROL

All construction staking, whether provided by the Contractor or the Owner, will be supervised by a land surveyor registered in the state in which the Work is located. Surveys will be performed consistent with professional practices and precision generally conducted by surveyors licensed in that state. Complete, legible survey notes will be maintained by the surveyors which show the locations and measurements required to establish construction staking. Such documents shall also provide information to identify the project, location of survey, date of survey, land surveyor's name and registration number. Copies of the Contractor's survey documentation shall be made available to the Owner upon request.

01560.3 OWNER RESPONSIBILITY**01560.3.1 FIELD LOCATION POINTS**

Unless otherwise indicated in the Contract Documents, the Owner shall provide information on the Drawings and sufficient surveyed points in the field to locate all features and components of the Contract. Typically, field location points will be established to consist of the following:

- 01560.3.1.1 **PRESSURE LINES** - When pressure lines are located in established streets or areas with sufficient referencing features (curb, sidewalks, fence lines, etc.), no staking will be provided and location information shall be provided on the Drawings. When pressure lines are located in areas without sufficient referencing features, stakes will be set to establish the pipe centerline at 100-foot intervals. Where sloping of lines is critical (drain lines, etc.) cut stakes will be provided to indicate flow line elevation at beginning and ends of such lines.
- 01560.3.1.2 **SEWER AND OPEN CHANNEL FLOW LINES AND MANHOLES** - Manhole centerline locations will be shown with horizontal offset stakes and cut stakes to indicate the elevation of the flow line. In addition, cut stakes will be set to provide horizontal locations and grade 100-feet upstream on lines flowing into manholes.
- 01560.3.1.3 **TANKS** - Circular tank centerline location will be staked and a benchmark (grade) stake will be provided to establish floor top elevation. Exterior corners of rectangular tanks will be staked and a benchmark will be established for establishing floor top. Stakes locating rectangular tank corners will also be provided offset reference stakes.
- 01560.3.1.4 **BUILDINGS AND OTHER STRUCTURES** - Two reference points with offset reference stakes will be provided to establish horizontal location of one wall or the centerline. A benchmark (grade) stake will also be provided to establish vertical elevations of the building/structure/s components.
- 01560.3.1.5 **ROADWAYS** - In all roadway construction, offset stakes that identify location of the centerline of road will be set at intervals not to exceed 100-feet. When roadway construction requires specific grading, stakes will be set at the beginning points of cuts and fills with offset reference stakes. Hubs will be set to actual finished grades at the top edges of the subgrade and at each consecutive course of surfacing base. Hubs with offset reference stakes will be set on the centerline at the upstream and downstream lip of the flowline of all drainage pipes and structures. Staking intervals for roads with specified grading shall not exceed 100 feet in tangent sections and 50 feet in curved sections. When curbing and/or sidewalks are constructed along roadways, offset stakes with horizontal and vertical

referencing information will be set at intervals of not more than 50 feet. Bench marks for checking and establishing vertical elevations shall be set at intervals not more than 1000 feet apart.

01560.3.1.6 **PONDS AND LAGOONS** - Offset stakes which identify the centerline and cut/fill stakes with offset reference stakes will be set at intervals of not more than 100 feet as well as at the beginning and end of all curved sections of banks. At least one benchmark shall be provided for each cell of the pond for establishing and verifying vertical elevations.

01560.3.2 **COST OF ERRORS**

The Owner shall be responsible for the accuracy of any staking, measurements, grades and alignment set by its own surveys. The Owner shall cover costs resulting from staking errors attributable to the Owner's survey.

01560.4 CONTRACTOR RESPONSIBILITY

01560.4.1 **ESTABLISHMENT OF GRADES, ETC.**

The Contractor shall establish any grades, elevations and distances required for its construction operation from the control staking provided by the Owner and described above. The Contractor shall advise the Owner of anticipated conditions which will affect location of offset stakes and protect the control staking from its construction operation. Where control staking has been damaged or obliterated by the Contractor's operation, replacement of the staking shall be made in accordance with the provisions of the General Conditions.

01560.4.2 **ERRORS IN CONSTRUCTION STAKING**

When the Contractor observes discrepancies or errors in the control staking, such problems shall immediately be brought to the attention of the Engineer, and the Engineer shall take corrective action as necessary to resolve the problem.

01560.4.3 **ACCURACY IN CONTRACTOR SURVEYING**

The Contractor shall be responsible for the accuracy of any staking, measurements, grades, and alignments set by its own surveys. Any costs resulting from staking errors attributable to the Contractor shall be borne by the Contractor. The Engineer reserves the discretionary right to check the Contractor's staking, grades and measurements randomly at any time. When such checking is to be exercised, the Engineer will notify the Contractor of the location and the time at which the checking will commence. The Contractor shall then stop any respective part of the Work in progress until the Engineer has notified the Contractor that the checking has been completed and the Work has been found to be in accordance with requirements of the Contract Documents.

01580.1 DESCRIPTION

In general, the Contractor is responsible for providing and maintaining access to the Work, handling and storing of materials and equipment, safety and security within the Work site, and coordination and cooperation with the Owner, its representatives, governing authorities and other contractors working for the Owner in accordance with the provisions of the General Conditions. This section contains specific requirements which apply to these responsibilities.

01580.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 02005 – Traffic Control

01580.1.2 SUBMITTALS

Not used.

01580.1.3 DEFINITIONS

Not used.

01580.2 WORK SITE ACCESS**01580.2.1 INVESTIGATION OF WORK SITE AREA**

The Contractor shall make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting ingress and egress to the site of the work.

01580.2.2 HAUL ROADS

It shall be the Contractor's responsibility to construct and maintain any new haul roads required for its construction operations.

01580.2.3 USE OF PUBLIC STREETS AND ALLEYWAYS

Nothing herein shall be construed to entitle the Contractor to the exclusive use of any public street, alleyway, or parking area during the performance of the Work, unless shown otherwise in the Contract Documents.

01580.2.4 CLOSURE OF PUBLIC ROADWAYS

No street, road, or highway shall be closed to the public without first obtaining permission from the proper governmental authorities and the Engineer. Where excavation is being performed in streets or highways, one lane in each direction shall be kept open to traffic at all times, unless otherwise authorized by the Contract Documents or the Engineer. Toe boards, or other measures, may be required by the Engineer to retain excavated material when deemed necessary.

01580.2.5 INTERFERENCE WITH UTILITIES

The Contractor shall so conduct operations as not to interfere unnecessarily with the infrastructure of utility companies or other agencies in such streets, alleyways, or parking areas.

01580.3 PUBLIC SAFETY AND ACCESS

Fire hydrants, approaches to fire stations, police stations and hospitals on or adjacent to the Work shall be kept accessible at all times. Appropriate measures shall be taken by the Contractor, to assure the use of sidewalks, and the proper functioning of all gutters, sewer inlets, water mains, drainage facilities and other infrastructure.

The Contractor's responsibility for Work safety or liability for Work site accidents is not lessened by the presence of the Engineer or his or another inspector performing monitoring of Work site safety conditions.

See also Section 02005 – Traffic Control.

01580.4 CONTRACTOR'S USE OF THE WORK SITE

The Contractor's use of the Work site shall be limited to its construction operations. Written approval by the Engineer will be required for any other use of the site, such as material and equipment storage, personnel vehicle parking, on-site fabrication facilities and field office.

01580.5 OFF-SITE STORAGE

The Contractor shall make arrangements for, bear any use costs associated with, and obtain written permission from the Engineer prior to using any off-site storage or shop areas or facilities determined necessary for execution of the Work. Storage facilities shall be equipped with fences and/or lockable entries that will prevent entry by unauthorized parties. Before off-site storage facilities are placed in use, the Contractor shall provided the Owner keys or combinations to locking devices used to secure the facility.

01580.6 COOPERATION WITH OTHER CONTRACTORS

Prior to authorizing other contractors to work on or adjacent to the Work site, the Owner shall notify the Contractor in writing and provide the name and address of the contractor, the name of its supervisor, a description of the work to be performed, and a schedule which shows the dates and planned segments of the work to be completed by the other contractor. In the event that conflicts or interferences occur between the Contractor and the other contractor's operation, the Engineer shall be notified immediately. The Engineer shall then take appropriate action needed to resolve the problem.

DIVISION 2

SITWORK



02000.1 DESCRIPTION

This section describes various tasks associated with project execution and close out. Mobilization shall include: preparatory work and materials necessary for obtaining clearances for the Work; moving personnel, equipment, supplies and incidentals to and from the Project Site; quality control; clean-up; temporary utilities and quarters; permits, bonds and insurance; dust abatement, storm water control, and noise abatement; waste and rubbish disposal and control; sanitation; and project close-out operations.

02000.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 01200 - Contract Closeout
Section 01510 - Protection of Existing Property
Section 01520 - Environmental Controls
Section 02005 - Traffic Control

02000.1.2 SUBMITTALS

02000.1.2.1 VISUAL RECORDS - The Contractor shall furnish at least one copy of all visual records, as described below in 02000.3.2, to the Owner.

02000.1.2.2 SERVICE CONNECTION LOCATION AND DOCUMENTATION – When service connections are included in the scope of work the Contractor shall deliver all signed tie-sheets (see 02000.3.3 below) to the Engineer not less than forty-eight hours prior to when the service connection is to be installed.

02000.1.3 DEFINITIONS

Sign - A complete assembly including panel and posts, with fasteners, installed at designated locations.

DVD Record - Photography on DVDs of areas potentially liable for disturbance as a result of the Work required by this Contract.

Service Connection Interview & Documentation - Interviews with potential system users and the documentation of location data for service connections to the respective property from utility lines being installed under this Contract.

Tie Sheets - Forms provided by the Engineer for use in documenting the location of service connection/s of system users.

Service Connection - Piping extending from the main utility line to the property line, or designated connecting point, of any user of the system.

02000.2 MATERIALS**02000.2.1 SIGN PANELS**

5/8-inch thick (A or B) exterior grade plywood sheets with best quality exterior enamel paint for face painting and lettering, fastened to posts with at least four 1/2-inch galvanized bolts.

02000.2.2 POSTS

4x4 Cedar or treated Pine commercial fence posts at least eight-feet long or as shown on the Drawings.

02000.2.3 VISUAL RECORD

Records shall be made on professional quality, standard DVD format recording. DVD's shall be provided with protective covers and shall be labeled to indicate the area covered by the photography.

02000.3 CONSTRUCTION REQUIREMENTS**02000.3.1 PROJECT SIGN**

The Contractor shall provide project signs, which includes furnishing all materials and labor to fabricate, deliver, install and maintain any and all project identification signs as detailed on Drawings and at location(s) shown thereon.

02000.3.2 VISUAL RECORDS

Prior to any disturbance of the area, the Contractor shall produce a DVD photography of all areas, including but not limited to right-of-ways, streets and roadways, haul-roads and access routes, storage areas, construction sites, and buildings or structures, which will be, or may be, affected by the Work. Such photography will be of a quality to allow accurate determination of location, size, and condition of existing features and improvements taken prior to any occupancy or execution of Work by the Contractor. Additionally, video for each street shall be separated into different chapters, which should each be accessible from the startup menu. Coverage should be taken while the camera is stationary, not from a moving vehicle or other means. DVD's are subject to approval by the engineer and owner. Construction may not begin until the engineer has approved the visual record.

02000.3.3 SERVICE CONNECTION LOCATION AND DOCUMENTATION

Unless called for differently, the Contractor shall contact and interview the owners of all properties indicated on the Drawings and obtain from them sufficient information for location of workable service connections for each property. The Contractor shall document those locations on the tie sheets and obtain a confirmation signature from the connection owner.

02000.4 METHOD OF MEASUREMENT**02000.4.1 MOBILIZATION**

Mobilization shall be measured by the lump sum.

02000.4.2 PROJECT SIGN

Measurement for project signs shall be made by counting each sign installed and accepted.

02000.4.3 VISUAL RECORDS

Pre-Construction Photography shall be measured by the lump sum.

02000.4.4 SERVICE CONNECTION DOCUMENTATION

Service Connection Documentation shall be measured by the lump sum.

02000.5 BASIS OF PAYMENT

02000.5.1 The accepted quantity(s) shall be paid for at the contract unit price for:

PAYMENT ITEM	UNIT
Mobilization	Lump Sum
Project Sign	Each
Pre-Construction DVD	Lump Sum
Service Connection Documentation	Lump Sum

02000.5.2 PAYMENT SCHEDULE

The amount bid or identified in a schedule of values for Mobilization shall not exceed 10% of the total contract bid amount. The following payment schedule percentages shall be based on amount bid or identified in a schedule of values for Mobilization up to a maximum of 10% of the total contract bid.

Partial payments for Mobilization will be made in accordance with the payment schedule table below.

MOBILIZATION PAYMENT SCHEDULE

Payment	Amount	When Paid
1 ST	25% of mobilization	With first partial payment after 3% of the original contract amount earned by the Contractor.
2 ND	25% of mobilization	When amount earned by Contractor is 10% of the original contract price.
3 RD	25% of mobilization	When amount earned by Contractor is 50% of the original contract price.
4 TH (last)	25% of mobilization	When project is complete and accepted.

SPECIAL PROVISION

MOBILIZATION	SECTION SP02000
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02000.6 STORM WATER POLLUTION PREVENTION PLAN

02000.6.1 The contractor shall provide, implement and maintain a storm water pollution prevention plan as outlined by the State of Utah DWQ. Attached is the Storm Water General Permit for Construction Activities, Permit No UTRC00000 found at <https://deq.utah.gov/water-quality/general-construction-storm-water-updes-permits> which outlines the required steps for preparing and maintaining the SWPPP, provides guidelines, examples, templates, BMP specifications, etc. The contractor will be listed as an operator.

02000.7 METHOD OF MEASUREMENT

02000.7.1 The measurement shall be lump sum.

02000.8 BASIS OF PAYMENT

02000.8.1 Payment schedule for the SWPP Plan shall be included into the payment of the mobilization and shall be paid as specified by in Mobilization Specification number 02000.

02005.1 DESCRIPTION

This section covers furnishing and maintaining all traffic control devices, flaggers and pilot vehicles necessary for protection of the Work, the workers and the traveling public in accordance with these Contract Documents. The requirements of this section are not intended to supersede, but shall supplement, the provisions contained in the "Manual of Uniform Traffic Control Devices" issued by the U.S. Department of Transportation, and any other applicable state or local traffic control regulations.

02005.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 01580 – Work Site Management
Section 02206 – Access Roads and Temporary Use of Roads

02005.1.2 SUBMITTALS

The Contractor, upon request of the Owner or Engineer, shall submit detailed traffic control plans for specific areas of the Work.

02005.1.3 DEFINITIONS

Traffic Control Devices - All temporary traffic control and warning devices required to warn traffic of, and to guide it through, construction areas as required under this Contract, including, but not limited to: portable cones and barricades, signs, channeling devices, paint striping, lighting devices, flags, etc.

Flaggers - Qualified and alert persons equipped with safety warning devices who direct traffic through construction areas.

Traffic Lane - Ten (10) feet of clear street width with a safe motor vehicle speed of twenty-five (25) miles per hour.

Pilot Car - Any designated and properly marked vehicle used for leading groups of vehicular traffic through construction areas.

02005.2 MATERIALS

Not Used.

02005.3 CONSTRUCTION REQUIREMENTS**02005.3.1 COORDINATION OF WORK AND TRAFFIC CONTROL**

The Contractor shall endeavor to organize its work force in such a manner as to minimize the closure of public streets and roadways within the Work site. If conditions justify, the Engineer may direct the Contractor to conduct Work in specific areas and/or to specific tasks to avoid closure or interference with traffic on public streets and roadways.

02005.3.2 CLOSURE OF PUBLIC THOROUGHFARES

The Contractor shall not close any public street or roadway without prior approval by the Engineer. When closure is necessary, and approved, the street or roadway shall only be closed to through traffic and not to local traffic. Closure may extend for one city block only, or 700 feet,

whichever is less. Closure of streets and roadways shall be made with barricades meeting State DOT standards. Traffic shall be kept open on streets and roadways where no detour is possible.

02005.3.3 MAINTENANCE OF EXISTING SIGNS

Existing traffic signs other than stop, yield, and street name signs shall be maintained by the Contractor until such time as construction renders them obsolete. At that time the Contractor shall remove signs and posts without damage and deliver them as directed by the Engineer.

02005.3.4 PROTECTION OF WORK AND TRAFFIC

All obstructions and excavations, within traveled streets and roadways, shall be protected with traffic control devices meeting State DOT standards. Traffic control devices, placed within streets and roadways, shall be illuminated at night, and such illumination shall function from sunset to sunrise. Local jurisdiction may require traffic control measures greater than those of State DOT standards, in which case the Contractor shall comply with such requirements.

Whenever the Engineer finds traffic control conditions at the Work site to be inadequate to assure public safety, or the Contractor's protective facilities to be inadequate, the Engineer may require the Contractor to provide the additional necessary facilities or services. The Contractor shall bear the cost of the additional protection.

See also Subsection 01580.3.

02005.4 METHOD OF MEASUREMENT**02005.4.1 TRAFFIC CONTROL AS LUMP SUM**

If traffic control appears as a separate item in the Bid Schedule, it shall be measured as a lump sum item. Therefore, with the possible exception of the items mentioned in the following two paragraphs, no separate measurement will be made for furnishing and maintaining traffic control devices, personnel, or any vehicles or other equipment used for traffic control.

02005.4.2 FLAGGING

When flagging is listed separately in the Bid Schedule, the work of flag persons will be measured by counting the number of hours put in by each separate flag person. This measurement shall include the time and/or mileage for any vehicle or other equipment required for performing the flagging work.

02005.4.3 PILOT VEHICLE

When a requirement for the use of pilot vehicles is called for separately in the Bid Schedule, that use will be measured by counting the number of hours each separate vehicle is in actual operation piloting or otherwise directing traffic.

02005.5 BASIS OF PAYMENT

02005.5.1 Unless provided for in the Contract Documents, the cost of all traffic control, including flagman, barricades, pilot cars and other devices, shall be included in the Contract Price and no separate measurement and payment will be provided.

02005.5.2 When provided in the Bid Schedule, the generally accepted quantities for traffic control shall be:

PAYMENT ITEM	UNIT
Traffic Control	Lump Sum
Flaggers	Hours
Pilot Vehicles	Hours

02015.1 DESCRIPTION

This section covers the removal of vegetation, debris, and other obstacles from the defined rights-of-way and limits of the project area and/or construction work site.

02015.1.2 RELATED WORK

Section 01510 - Protection of Existing Properties
Section 02200 - Trench Excavation and Backfill
Section 02500 - Removal and Replacement of Surface Improvements
Section 02900 - Landscaping

02015.1.3 DEFINITIONS

Clearing - consists of removal and disposal of trees, stumps, logs, limbs, sticks, vegetation, rubbish, debris and other material on the natural ground surface.

Grubbing - consists of removing and disposing of roots (one-inch and larger diameter), tree stumps, buried logs, debris, and other underground obstructions.

02015.2 MATERIALS

Not used

02015.3 CONSTRUCTION REQUIREMENTS

Clear, grub, remove and dispose of all trees, vegetation and debris within the staked limits of the roadways, trenches, channels, easements, embankments, structures, and other designated areas. Do not injure or damage trees, shrubs, or other vegetation and objects to remain intact as designated by the Engineer or the Owner. Such items are to be fully protected from injury at the Contractor's expense.

02015.3.1 CLEARING

Areas within the limits of excavation and embankment slope stakes shall be cleared.

Tree branches extending over the area to be cleared and which hang within 12 feet of the ground surface shall be cut off in a neat and workmanlike manner. When such branch removal is necessary, the Contractor shall remove other adjacent branches on the tree under the direction of the Engineer so as to present a balanced appearance. Scars resulting from the removal of branches shall be treated with a heavy coat of approved tree sealant.

02015.3.2 GRUBBING

Grub all areas within the limits described as follows:

02015.3.2.1 FOR CONSTRUCTION OF ROADWAYS - Grub the area between the limits of the excavation and embankment slope stakes to a depth of two (2) feet below natural ground level to remove all stumps, roots, buried logs and other underground debris. However, when the roadway embankment already is two feet or more above the natural ground level, stumps cut less than 6 inches above natural ground, together with roots and other non-perishable obstructions, may remain in place.

02015.3.2.2 FOR CONSTRUCTION OF PONDS OR LAGOONS AND STRUCTURES - completely grub the pond area within the boundaries of the dikes or structures to a depth of two (2) feet and remove all stumps, roots, buried logs and other underground debris. Grubbing of this area shall include removal of the top 6-inches of organic laden topsoil and stockpiling it for later distribution over areas shown in the Contract Documents or directed by the Engineer.

02015.3.3 BACKFILLING

All stump holes, cuts, depressions and other holes resulting from clearing and grubbing operations within areas designated to receive pipelines, structures, or embankments shall be backfilled and compacted to the density of the surrounding ground.

02015.3.4 DISPOSAL

The Contractor shall dispose of all materials resulting from clearing and grubbing operations as required in the Contract Documents and in accordance with Section 01520 of these Specifications.

02015.3.5 MARKERS, MONUMENTS AND DATA POINTS

Land monuments, property markers or official datum points shall be protected until their removal is approved. When movement of monuments or markers is deemed necessary and approved by the Engineer, all such monuments or markers shall be carefully referenced for re-establishment before removing.

02015.4 METHOD OF MEASUREMENT

02015.4.1 SEPARATE PAYMENT

Measurement for "Clear and Grub" shall be made either as lump sum or by counting the number of acres. to the nearest tenth (10th), of area actually cleared and grubbed within the limits shown on the Drawings or as directed and approved by the Engineer. For areas where ponds or lagoons are to be constructed, this measurement shall include the removal and stockpiling of the first six (6) inches of topsoil in addition to grubbing to the required depths.

02015.4.2 NO MEASUREMENT

02015.4.2.1 NO PAY ITEM FOR CLEAR & GRUB - When the Bid Schedule does not contain a pay item for "Clear and Grub", then that work will be considered incidental to other Work items which require clearing and grubbing and no separate measurement shall be made.

02015.4.2.2 ROADWAY EXCAVATION and/or BORROW - Material used for filling depressions will be measured separately only when "Roadway Excavation" and/or "Borrow" appear as separate pay items on the Bid Schedule. Measurement will be made by counting the number of cubic yards of material moved and placed as designated on the Drawings or as directed and approved by the Engineer. If "Roadway Excavation" or "Borrow" are not included in the Bid Schedule, material used for filling depressions will not be measured separately, but will be considered incidental to the Work.

02015.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price.

PAYMENT ITEM	UNIT
Clear and Grub	Lump Sum
Clear and Grub	10 th of Acre

02020.1 DESCRIPTION

Furnish and provide labor and equipment for investigation of existing miscellaneous pipelines, wires or cables, and other miscellaneous sub-surface features as required by the Engineer.

02020.1.1 RELATED WORK

Section 01510 - Protection of Existing Improvements

02020.1.2 SUBMITTALS

Not used.

02020.1.3 DEFINITIONS

Not used.

02020.2 MATERIALS

The Contractor shall provide a backhoe and qualified operator; laborer with hand shovel; appropriate fuel and lubricants, necessary equipment servicing materials; and appropriate equipment for transporting the backhoe to perform the investigation. The backhoe shall be a rubber tired CASE 580 backhoe, or an approved unit of equivalent or greater size and capacity, having accumulated not more than 5,000 hours operating time.

02020.3 CONSTRUCTION REQUIREMENTS**02020.3.1 EXPOSURE BY EXCAVATION**

When directed by the Engineer, the Contractor shall excavate and expose miscellaneous pipelines, structural features, soil materials and other underground features which may be present at the work site. The location and extent of exposure shall be determined on site by the Engineer. Designation of such areas shall be made in writing, usually in the form of a Work Order, by the Engineer.

02020.3.2 REPLACEMENT OF EXCAVATED MATERIALS

Work required hereunder shall include replacement of excavated materials sufficiently to restore the site to a safe condition as determined by the Engineer. Full restoration of materials such as pavement, concrete slabwork, sod, etc., in the investigated area will be accomplished in accordance with the Contract Documents and as directed by the Engineer.

02020.4 METHOD OF MEASUREMENT**02020.4.1 MEASUREMENT BY HOURS OF WORK**

Measurement of subsurface investigation shall be made by counting the actual number of hours of work completed by the machine and operator to investigate miscellaneous underground features as required by the Engineer. No allowance of time will be made for transporting the backhoe to and from the job site when the backhoe is located on the site of the Contract.

02020.4.2 MEASUREMENT FOR OTHER ITEMS OF WORK

When restoration of the excavated area requires provision of pavement, concrete slabwork, sod, etc., separate measurement will be made for those materials in accordance with the respective requirement(s) for measurement of that item in the Contract Documents.

02020.5 BASIS OF PAYMENT

The accepted quantity of work will be paid for at the contract unit price of:

PAYMENT ITEM	UNIT
Subsurface Investigation	Hour

When provision of designated materials is required for restoration of the excavation, payment for such materials shall be made in accordance with the respective provisions of the Contract documents.

02105.1 DESCRIPTION

This section covers obtaining permission, permits, clearances, etc.; as necessary to develop source(s), purchasing or manufacturing, loading, hauling, placing and compacting earthwork materials described herein, as shown on the Drawings and/or required by these Specifications.

02105.1.1 RELATED WORK

Section 02200 - Trench Excavation and Backfill

02105.1.2 SUBMITTALS

When the Bid Schedule indicates quantities of materials described in this section in excess of 50 cubic yards or 50 tons, or when requested otherwise by the Engineer, the Contractor shall provide test results from a certified independent laboratory which has sampled and performed the prescribed test(s) for those materials.

02105.1.3 DEFINITIONS

Granular Material - Material for which the sum of plasticity index (AASHTO T-90) and the percent of material passing a No. 200 sieve (AASHTO T-27) shall not exceed 23.

Silt - Material which passes the No. 200 (AASHTO T-11) sieve and has a plasticity index not greater than 10.

Clay - Material which passes the No. 200 sieve and has a plasticity index greater than 10.

Bedding - Materials placed immediately around and adjacent to pipe installed in trenches.

Borrow - Material obtained from a source away from the site on which installed and/or excavated and used to supplement insufficient quantities of material required.

02105.2 MATERIALS**02105.2.1 ON-SITE TRENCH OR STRUCTURAL BACKFILL**

On-site trench or structural backfill consists of material excavated during trenching or foundation excavation which is free of cinders, ashes, wood, vegetation, frozen or other deleterious material or rocks with a maximum particle size not greater than 6-inches. Material may be required to be processed or transported along the excavation.

02105.2.2 IMPORTED TRENCH OR STRUCTURAL BACKFILL

Imported trench or structural backfill consists of granular material obtained from sources indicated on the Drawings, designated in the Special Provisions or approved by the Engineer. Borrow materials shall be free of cinders, ashes, wood, vegetative matter, frozen or other deleterious matter with a maximum particle size not greater than 6-inches. Pit Run Borrow may be used as backfill in trenches, excavations for structures, in roadway subgrades, or as otherwise shown on the plans or called for by the Engineer. Material may be processed or may be pit run.

02105.2.3 ON-SITE PIPE BEDDING

On-site pipe bedding consists of material excavated during the trenching operation which is free of cinders, ashes, wood, vegetation, frozen or other deleterious material or rocks with a maximum

particle size not greater than that shown below in Table 1. Material may be required to be processed or transported along the trenching operation.

02105.2.4 IMPORTED PIPE BEDDING

Imported pipe bedding consists of granular material excavated from an approved borrow source which is free of cinders, ashes, wood, vegetation, frozen or other deleterious material or rocks with a maximum particle size not greater than that shown in Table 1 below. Material may be processed or may be pit run.

Table 1 - MAXIMUM PARTICLE SIZE FOR PIPE BEDDING

Pipe	Size
Corrugated Metal and Welded Steel	1"
Polyethylene, Galvanized Steel and PVC	3/4" in Utah or 1" in other states
Ductile Iron, Cast Iron, Concrete, and HDPE	2"

02105.2.5 SAND

Sand shall be graded granular material which passes a 3/8-inch sieve, with not more than 10 percent passing the No. 200 sieve (AASHTO T-27) and free from cinders, ashes, wood, vegetation, frozen or other deleterious material.

02105.2.6 UNTREATED BASE COURSE

Untreated base course consists of processed natural gravel and crushed rock with an approved soil binder without any deleterious materials, tested in accordance with AASHTO T-27 and T-11 which meets the gradation requirements in Table 2 below.

Table 2 - PARTICLE SIZE FOR UNTREATED BASE COURSE

Sieve Size	Percent Passing
1-inch	100
1/2-inch	70-90
#4	40-60
#16	20-40
#200	5-12

02105.2.7 BITUMINOUS SURFACING

Plant mix bituminous material, with maximum particle size not greater than 3/4-inch, meeting the requirements of Section 02511 of these Specifications.

02105.2.8 DRAIN GRAVEL

Drain gravel consists of washed natural gravel or crushed rock, with a maximum particle size of 1-inch, with not more than 40 percent passing the No. 4 sieve, with 100 percent being retained on the No. 10 sieve, and without any deleterious material.

02105.2.9 RIPRAP

Riprap consists of durable, angular, sound and hard field or quarry stones free from cracks and structural defects. Source of supply shall be approved by the Engineer. Fifty percent of the stones shall be of sizes between one-half and two-thirds of the riprap layer thickness shown on the

Drawings. Not more than 10-percent of the stones by weight shall be of a size less than one-tenth of the riprap layer thickness shown on the Drawings and the specific gravity of the stones must range between 2.5 and 2.82 (AASHTO T-85). Durability of the stones shall be in excess of 40 percent (AASHTO T-210).

02105.2.10 SUBGRADE GRANULAR FILL

Subgrade granular fill consists of well graded granular soils with a maximum of 50 percent passing the No. 4 sieve and a maximum of 20 percent passing the No. 200 sieve and no materials greater than 4-inches in diameter.

02105.3 CONSTRUCTION REQUIREMENTS

02105.3.1 LOCAL GOVERNMENT SPECIFICATIONS

Differences may exist between the requirements of these Specifications for sitework materials such as backfill, bedding, untreated base course and bituminous surface course, and those of local government entities. Such differences may affect Contract prices; therefore, when Contract Work falls within the boundaries of any local government, the Contractor shall make himself aware of that entity's specifications for those materials. If differences exist between those specifications and these, unless otherwise approved by the Engineer, the more stringent ones shall apply.

02105.3.2 BORROW AND DISPOSAL SITES

The Contractor shall, at its own expense, secure all necessary access and borrow sites for acquisition or removal and to dispose of excess backfill or waste materials, unless otherwise shown on the Drawings.

02105.3.3 ON-SITE MATERIALS

Unless otherwise shown on the Drawings or directed by the Engineer, on-site pipe bedding and trench backfill will be used for installation of all pipe. In areas where suitable on-site material is not available, other material, which meets these Specifications, will be used when shown on the Drawings, provided for in these Contract Documents or approved by the Engineer.

02105.3.4 SCALES

When ton weight is to be used to determine quantities of earthwork materials used, the Contractor shall provide his own scales or access to other scales at his own cost. Scales shall be certified accurate. Include certification in submittals.

02105.4 METHOD OF MEASUREMENT

02105.4.1 NO MEASUREMENT

On-Site Pipe Bedding and On-site Trench or Structural Backfill will be considered part of the items for piping or excavation associated with structures included in the Bid Schedule and no separate measurement for these materials will be made.

02105.4.2 SEPARATE MEASUREMENT

02105.4.2.1 IMPORTED MATERIALS – Quantities of imported pipe bedding and imported trench or structural backfill shall be determined by measuring the lineal feet (lineal feet of trench requiring imported materials) of imported material in place and accepted. This measurement shall include

furnishing all necessary materials and equipment, labor, hauling, placement, compaction, and testing to produce an acceptable trench fill.

No allowance will be made for bedding and backfill materials required to fill voids caused by trenching operations, which exceed the dimensions shown on the Drawings.

02105.4.2.2 SAND – Quantities of sand shall be determined in cubic yards in place, calculated by multiplying the measured length of trench by the measured depth of bedding by the pay width shown on the Drawings, or as directed by the Engineer in the field.

No allowance will be made for materials required to fill voids caused by trenching operations, which exceed the dimensions shown on the Drawings.

02105.4.2.3 UNTREATED BASE COURSE - Quantities of untreated base course shall be determined in cubic yards in place, calculated by multiplying the measured length by neat line dimension shown on the drawings. If no neat lines are shown on the drawings, then the cubic yard calculations shall be determined by actual measurements in the field in place.

02105.4.2.4 BITUMINOUS SURFACING – Quantities of the respective compacted thickness of bituminous surfacing shall be determined in square yards by multiplying the length of material in place and accepted by the pay width shown on the Drawings, or as directed by the Engineer in the field.

02105.4.2.5 DRAIN GRAVEL - Quantities of drain gravel shall be determined in cubic yards calculated by multiplying the measured length by the measured depth of bedding in place by the pay width shown on the Drawings, or as directed by the Engineer in the field.

02105.4.2.6 RIPRAP - Quantities of riprap shall be determined in cubic yards by multiplying the measured length by the measured breadth by the measured average depth of material in place and accepted.

02105.4.2.7 SUBGRADE GRANULAR FILL - Quantities of subgrade granular fill shall be determined in cubic yards by multiplying the measured length by the measured breadth by the measured depth of material in place and accepted.

02105.5 BASIS OF PAYMENT

The accepted quantity shall be paid for at the contract unit price for:

PAYMENT ITEM	UNIT
Imported Trench or Structural Backfill	Lineal Foot
Imported Pipe Bedding	Lineal Foot
Sand	Cubic Yard
Untreated Base Course	Cubic Yard
Bituminous Surfacing (Thickness)	Square Yard
Drain Gravel	Cubic Yard
Riprap	Cubic Yard
Subgrade Granular Fill	Cubic Yard

SPECIAL PROVISION

EARTHWORK MATERIALS	SECTION SP 02105
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Amend the following sections to include:

02105.4 METHOD OF MEASUREMENT

02105.4.2.3 (THICKNESS) UNTREATED BASE COURSE – Quantities of untreated base course shall be determined in square yards, calculated by neat line dimensions shown on the drawings.

02105.4.2.3 UNTREATED BASE COURSE – Quantities of untreated base course shall be determined in cubic yards, calculated by neat line dimensions and thicknesses shown on the drawings and verified with load tickets.

02105.4.2.3 (THICKNESS) SUBGRADE GRANULAR FILL (GRANULAR BORROW) – Quantities of Subgrade Granular Fill (Granular Borrow) shall be determined in square yards, calculated by neat line dimensions shown on the drawings.

02105.4.2.3 SUBGRADE GRANULAR FILL (GRANULAR BORROW) – Quantities of Subgrade Granular Fill (Granular Borrow) be determined in cubic yards, calculated by neat line dimensions and thicknesses shown on the drawings and verified with load tickets.

02105.5 BASIS OF PAYMENT

The accepted quantities shall be paid for at the contract unit price:

PAYMENT ITEM	UNIT
(Thickness") Untreated Base Course	Square Yard
Untreated Base Course	Cubic Yard
(Thickness) Subgrade Granular Fill (Granular Borrow)	Square Yard
Subgrade Granular Fill (Granular Borrow)	Cubic Yard

02200.1 DESCRIPTION

This section covers furnishing of equipment, labor, and materials to clear, excavate, backfill and compact trenches for utilities. Excavation and backfill for piping appurtenances such as manholes, inlets, transition structures, junction structures, vaults, thrust blocks, valve boxes, catch basins, etc., shall be included, as also shall be restoration of the disturbed ground surface in accordance with the Contract Documents.

02200.1.1 RELATED WORK

Section 02005 – Traffic Control
Section 01510 - Protection of Existing Properties
Section 02015 - Clearing and Grubbing
Section 02105 - Earthwork Materials
Section 02208 - Flowable Backfill
Section 02222 - Water Pipe Installation
Section 02224 - Sewer Pipe and Manhole Installation
Section 02315 - Boring and Jacking
Section 02320 - Pipe Encasement
Section 02500 - Removal and Replacement of Surface Improvements
Section 02900 – Landscaping
Section 02204 – Water for Construction

02200.1.2 SUBMITTALS

02200.1.2.1 MOISTURE DENSITY TESTING AND GRADATION DETERMINATIONS - A documentation system shall be maintained by the Contractor to record results from all moisture/density testing and gradation determinations. Records of these tests shall show the following information as a minimum:

- Date of test.
- Type of test.
- Name of person performing test.
- Location of sample taken.
- Results of test and comparison with specified value required for compliance.

Upon completion of each gradation test or moisture/density test, a copy of the record for the respective test shall be delivered to the Engineer within one (1) working day following the completion.

02200.1.2.2 COMPLIANCE TESTING - Documentation shall also be made, in field diaries, of all compliance tests performed by the Contractor. Documentation shall be made available to the Engineer upon request.

02200.1.3 DEFINITIONS

Trench Width - Shall not be more than 18 inches greater than the outside diameter of the pipe being installed at a point 12 inches above the top of the pipe unless otherwise shown on the Drawings. The width of the trench above that level shall be the minimum width required for safe working conditions, sheeting, bracing and for proper installation of the work.

Trench Grade - The vertical elevation of the flowline of the pipe being installed in the trench.

Open Trench - Shall include trench sections which have been excavated and are awaiting completion of pipe installation, backfill, compaction or installation of a temporary surface.

Surface Restoration - Shall include the Work required to restore the ground surface disturbed for trench excavation. Replacement of road surfacing, planting and landscaping removed for trench excavation, will not be considered as trench excavation and backfilling.

Consolidated Backfill - A condition of backfilling for which a specified compaction density is required. Maximum lift, prior to compaction, for consolidated backfill shall be 8 inches unless otherwise approved by the Engineer.

Unconsolidated Backfill - A condition of backfilling for which no compaction density is specified and the required compaction effort is layer placing and then compacting by wheel rolling or use of compacting equipment. Lifts of up to 24 inches are allowed for unconsolidated backfill.

Unclassified Excavation - A determination for excavating whereby no consideration will be given to different kinds of materials that are encountered.

02200.2 MATERIALS

Not used.

02200.3 CONSTRUCTION REQUIREMENTS**02200.3.1 PERMITS**

For work which is to take place within state and/or federal road and highway rights-of-way, the Contractor shall be responsible for obtaining all required encroachment and construction permits prior to beginning any work within the rights-of-way.

All work in any city, town or county public right-of-way will also require an approved excavation permit from that entity. The Contractor shall be responsible for obtaining all required encroachment and construction permits prior to beginning any work within the rights-of-way.

02200.3.2 CLEARING AND GRUBBING

On areas outside of established roadways, the area to be disturbed by the trenching operation shall be cleared and grubbed in accordance with Section 02015 prior to beginning the trenching operation.

02200.3.3 EXCAVATION

02200.3.3.1 UNCLASSIFIED EXCAVATION - All excavation for this project shall be unclassified excavation, unless otherwise determined by the Engineer.

02200.3.3.2 STAKING - Location staking of piping will be provided by the Owner in accordance with the provisions of Section 1560 unless indicated otherwise in the Contract Documents.

02200.3.3.3 EXPOSURE OF UNDERGROUND FEATURES - Before any trench excavation is started, the Contractor shall locate and expose all existing underground utilities, structures, etc., which may interfere with, or conflict with, the trench being excavated. In case of conflicts, the Contractor shall make adjustments in the location of the excavation at the direction of the Engineer. Such adjustments shall be made at no additional cost to the Owner.

02200.3.3.4 The Contractor shall perform all excavation to the depth specified in the Drawings and/or as required to accomplish the Work. During the excavation operations, excavated materials which are suitable for use as backfill for trenches or around structures, shall be piled separately at sufficient distance from the edge of the excavation to be out of the way of equipment and to prevent slides and cave-ins from embankment overloading. All excavated materials not suitable for, or not required for, fill or backfill shall be separated and removed promptly from the site of the Work and disposed in an approved site in accordance with Section 1520.

02200.3.3.5 PUBLIC TRAVEL - Materials excavated within roadways, regardless of their disposition, shall be piled in such manner that will cause the minimum of inconvenience to public travel and always allow for emergency vehicle passage.

02200.3.3.6 OPEN TRENCH - At no time shall the Contractor allow more than 500 cumulative feet of trench to be open for the overall project, unless otherwise approved by the Engineer.

02200.3.3.7 SHORING - Shoring and/or trench boxes shall be used wherever needed to protect workers and adjacent structures and property of the Work in accordance with OSHA requirements. The arrangement of bracing of shoring shall not be set so as to stress any portion of completed work.

02200.3.3.8 BARRICADING OPEN WORK - Excavations left open at the end of the work day shall be surrounded by barricades and warning tape.

02200.3.4 EXCAVATION IN ROCK

02200.3.4.1 SOLID ROCK EXCAVATION

Solid rock excavation will receive special consideration IF the following applies:

- The Contract Documents contain measurement and payment provisions for “Solid Rock Excavation”, and
- Solid rock excavation is not included in another bid item, and
- Solid rock has been encountered in the excavation, and
- The Contractor has made ample (as determined by the Engineer) attempts to remove the rock using an excavator weighing not less than 74,000 lbs, such as a Cat 330B; then the excavation of such material will be considered as “solid rock excavation”. As a general rule, if the specified excavator using a 30” bucket with rock teeth, requires more than two minutes to remove one (1) full bucket of material, the material is considered solid rock.

If the Contractor encounters solid rock (as described above) at a thickness greater than 12 inches, then the entire trench is considered “Solid Rock” and the Contractor will be reimbursed as outlined in the Measurement and Payment sections.

02200.3.4.2 BLASTING - When blasting is deemed necessary for rock removal, the Contractor shall comply with all applicable State and Local laws, ordinances, and provisions for blasting safety and obtain written approval from the Engineer prior to starting of drilling and/or blasting operations.

In all cases, blasting shall be performed by experienced, qualified blasters. The Contractor is responsible for any and all damage caused by blasting, and blasting will not be allowed within 15 feet of any existing structures.

If for any reason, the Contractor chooses to blast any portion, it is understood that the blasting areas chosen by the Contractor are not necessarily considered "Solid Rock" until the trench is open and visually inspected by the Engineer, at which time a determination will be made to consider it "Solid Rock".

02200.3.5 OVER-EXCAVATION

02200.3.5.1 UNAUTHORIZED OVER-EXCAVATION - Care shall be taken to not excavate below the depth required by the Drawings. Any unauthorized over-excavation shall be refilled and compacted with material meeting the requirements of Section 02105 and approved for use by the Engineer at the expense of Contractor.

02200.3.5.2 ROCK - Whenever rock is encountered in the trench bottom, the trench shall be over-excavated a minimum of 6 inches below the design elevation of the bottom of the pipe. The over-excavated portion of the trench shall be filled with approved bedding material and the bedding compacted, all at the expense of the Contractor, unless otherwise approved by the Engineer and the Owner.

02200.3.5.3 UNSTABLE NATIVE FORMATIONS - The Contractor shall notify the Engineer if soft, spongy, or otherwise unstable native formations, that are not suitable for structure or pipeline foundations, are encountered in excavations. In the event the Engineer determines that the existing foundation materials are unacceptable, the Contractor will be directed to over-excavate, remove and replace the unsuitable soil materials. The over-excavation shall be backfilled with approved select materials and compacted in accordance with the requirements described herein. Such situation will be considered as a changed condition and the Contractor will be compensated in accordance with the General Conditions.

02200.3.6 PIPELINE ACCESSORY INSTALLATION

02200.3.6.1 EXCAVATION FOR ACCESSORIES - The Contractor may excavate to place the sides of manholes, vaults, valve boxes, inlet structures, catch basins or other accessory structures directly against the excavated surface, provided that the faces of the excavation are firm and unyielding and are at all points outside the structure lines shown on the plans. If the native material is such that it will not stand without sloughing, the Contractor shall over-excavate to place the structure and this over-excavation shall be backfilled and compacted, using the same material required for the adjoining pipeline trench.

02200.3.6.2 ACCESSORY SUPPORT - To prevent displacement of valve boxes and other accessory structures, trench backfill shall be compacted to at least 95% of maximum density as determined by AASHTO T-99 for 6 feet along the trench on each side of the box or structure.

02200.3.7 TRENCH BOTTOM PREPARATION

The bottom of the trench shall be accurately graded to provide uniform bearing and support for each section of the pipe. Bell or coupling holes shall be made in accordance with the recommendations of the pipe manufacturer after the trench bottom has been graded. Such depressions shall be of sufficient width to provide clearance for connecting and/or bolting. Holes for depressions shall be excavated only as necessary to permit proper joining of pipe sections.

02200.3.8 SURFACE IMPROVEMENTS

When surface improvements must be removed, or are damaged or disturbed by the Work, their removal and restoration shall be accomplished by the Contractor in accordance with Sections 01510 and 02500 of these Specifications.

02200.3.9 PROTECTION OF EXISTING UTILITIES

The Contractor shall protect all existing utilities, either above or below ground, in accordance with the provisions of Section 01510 of these Specifications.

02200.3.10 IRRIGATION DITCHES, PIPES AND STRUCTURES

The Contractor shall contact the owners of all irrigation facilities to be encountered by the work and make arrangements for construction clearances and/or facility shutdown schedules. All irrigation ditches, dikes, headgates, pipe, valves, culverts, etc., damaged or removed by the Contractor shall be restored by the Contractor to their original condition, or better, in accordance with Section 02500 of these Specifications, at no additional cost to the Owner.

02200.3.11 BUILDING FOUNDATIONS AND STRUCTURES

Where trenches are located adjacent to building foundations and structures, the Contractor shall take all necessary precaution against damage to such facilities. Water settling of backfill material in trenches adjacent to structures will not be permitted unless authorized in writing by the Engineer. The Contractor shall be liable for any damage caused by the construction, and shall restore or replace damaged property in accordance with Section 02500 of these Specifications.

02200.3.11.1 SIDEWALK, CURB AND GUTTER - Where sidewalk, curb, and gutter exist, excavation may be made by tunneling provided the following requirements are met. Excavation shall be vertical and as near to the curb or sidewalk as possible. The length of the tunnel shall not exceed the width of the sidewalk, curb and gutter. Where a separate sidewalk and curb exist, an excavation shall be made between the sidewalk and the curb. At least three feet of undisturbed earth shall be left under the sidewalk. Where the excavation does not meet these requirements, a section of sidewalk from joint to joint shall be removed and replaced.

Gas Lines and Water Lines may be jacked, augured or jetted under sidewalk, curb and gutter provided the resulting hole diameter does not exceed one (1) inch plus the outside diameter of the pipe installed.

Backfill of Sidewalk Tunnels. Where the sidewalk has been tunneled, the hole shall be filled from each end with earth compacted with mechanical tampers to 90% of AASHTO T-180, Method C. A 3'-0" section of trench on each side of the tunnel and any space between the sidewalk and curb shall be backfilled with mechanically compacted earth as specified.

02200.3.12 WATER

02200.3.12.1 WATER FLOW - The Contractor's operation shall always ensure the free flow of water in gutters, culverts, and natural watercourses. In irrigated land areas, excavated materials shall be piled on the downhill sides of trenches.

02200.3.12.2 GROUNDWATER – Unless provided with geotechnical information by the Owner, the Contractor shall have the responsibility of determining the presence and location of groundwater at the work site.

02200.3.12.3 DEWATERING - Grading and other protective measures shall be performed as necessary to prevent surface or ground water from flowing into trenches or other excavations. Any water accumulated therein during construction, from surface or from underground sources, shall be promptly removed by pumping or by other approved methods at the Contractor's expense.

Unless given as a separate item in the Bid Schedule, dewatering shall be performed at the expense of the Contractor. When geotechnical information is given, groundwater must be in excess of ± 2 feet before a change in work will be considered.

02200.3.12.4 **INSTALLATION IN WATER** - No backfill, subgrade materials, concrete or masonry footings, foundations, floors, equipment, or pipe shall be placed or laid in water. Water shall not be allowed to rise over such work for at least 24 hours following the pour or placement of any concrete or mortar used in the work. Water shall not be allowed to rise unequally against structure walls for a period of 14 days following concrete placement or masonry erection.

Groundwater or surface water in piping trenches shall not be allowed to enter and flow through the piping while installation of pipe is in progress.

02200.3.12.5 **DISPOSAL** - The Contractor shall dispose of all water from the work in a suitable manner without damage to adjacent property

02200.3.13 **BEDDING AND PIPELINES**

02200.3.13.1 **USE OF ON-SITE MATERIALS** - Unless directed otherwise in these Specifications, on-site materials complying with Section 02105 shall be used for bedding. If an act, or failure to act on the part of the Contractor creates a need to use imported bedding materials, the Contractor shall bear the cost of all additional excavation, transportation and installation for new bedding, and for removal and disposal of unacceptable materials, as required to correct that situation.

02200.3.13.2 **INSUFFICIENT ON-SITE MATERIALS** - When sufficient bedding material cannot be developed from on-site materials, and no provision is contained in the Contract Documents for importing bedding materials, the Engineer shall be notified as soon as possible. Alternative measures will be considered and a change can then be negotiated to provide additional materials in accordance with the General Conditions.

02200.3.13.3 **BEDDING INSTALLATION** - Pipe bedding shall be installed according to applicable sections of these Specifications for pipeline construction.

02200.3.14 **BACKFILL**

02200.3.14.1 **BACKFILL MATERIALS AND PLACEMENT** - Backfill shall be accomplished using acceptable materials as described in Section 02105 as follows:

- All backfill materials shall be at $\pm 2\%$ of optimum moisture content when placed in the trench or other excavation.
- Unless provided otherwise on the Drawings, consolidated trench backfill shall be placed in lifts not greater than 8 inches.
- Unsuitable excavated material, or material with incorrect moisture content shall be removed and replaced.
- Soft spongy material that causes areas which “pump” when heavy loads pass over them, shall be removed and replaced with suitable material.
- Dry material that will not “ball” shall be removed and replaced.

(The two foregoing conditions shall be considered sufficient evidence, without further testing, that the moisture content is incorrect and shall be grounds for removal and replacement of the material. Such replacement, if required, shall be at the sole expense of the Contractor.)

- Placement of backfill against cast-in-place concrete structures shall not be started until the concrete has been cured for the time required by the Contract Documents or prescribed by the Engineer.

02200.3.14.2 **COMPACTION** – Compaction procedures shall be as follows:

- The Contractor shall be responsible for obtaining construction water needed for compaction in accordance with Section 02204 of these Specifications.
- Bedding and consolidated backfill material shall be compacted with tamping, vibrating or conventional wheeled compaction equipment. Use care not to damage pipe while compacting bedding materials.
- The use of wheel rolling for compaction shall only be approved for compacting unconsolidated backfill materials.
- For work within state or federal highway rights-of-way, compaction shall meet the requirements of the respective applicable specifications.
- Backfill shall be thoroughly compacted to densities not less than those shown in the following table:

**TABLE OF MINIMUM DENSITY REQUIREMENTS
(based on AASHTO-99 and T-91 and on ASTM D-2922 and E-3017)**

Location	From Surface to 2-Feet Below Surface	From 2-Feet Below Surface to Top of Bedding	Bedding
Within 6 feet of, and/or under, any existing or proposed structure, pavement, curb, sidewalk, roadway or similar construction included in the Contract:	100% for granular and 95% for non-granular materials	95% for all materials	95% at all locations
Around any structure outside 6 feet:	90% for all materials	90% for all materials	90% at all locations
Cultivated and landscaped areas:	85% for all materials	85% for all materials	85% at all locations
Undeveloped Land:	Unconsolidated – see definition	Unconsolidated - see definition	85% at all locations

02200.3.15 **SETTLING AND SUBSIDENCE**

Dips or uneven surfaces caused by subsidence or post-construction settlement of fill or backfill in any trenches, excavations, fills, or embankments within the work, which become apparent within the warranty period, shall be repaired by the Contractor at no additional cost to the Owner.

02200.3.16 **SAMPLING AND TESTING**

02200.3.16.1 **TESTING BY INDEPENDENT LABORATORY** - As directed by the Engineer, the Contractor shall provide for all sampling and testing through a qualified, independent testing laboratory at the Contractor’s own expense.

02200.3.16.2 **SCHEDULE OF SAMPLING AND TESTING** - The following schedule of sampling and testing provides minimum requirements, to assure compliance with all materials and compaction

requirements described herein. The number of samples and tests shown shall be considered minimum, and field conditions may necessitate additional sampling and testing to be required by the Engineer.

GRADATION DETERMINATION (AASHTO T-27 and T-11)

<u>Trench Location</u>	<u>Testing Required</u>
Materials imported or manufactured at a site determined by this contract	One test per site or source
On-site excavated materials along trenches.	One test per geographical area where material composition and gradation visually appears consistent.

**MOISTURE/DENSITY RELATIONSHIP (Proctor)
(AASHTO T-99 or T-180 Method D)**

<u>Trench Location</u>	<u>Testing Required</u>
Materials imported or manufactured at a site determined by this Contract.	One test per site unless the material visually appears to change.
On-site excavated materials along trenches.	One test per geographical area where material composition visually appears consistent.

**COMPACTION COMPLIANCE TESTING REQUIREMENTS
(AASHTO T-191 or Portable Nuclear Gauges)**

<u>Trench Location</u>	<u>Testing Required</u>
Street crossing with gravel or bituminous surfacing.	One test per lift for each crossing.
Parallel to centerline of bituminous or gravel surfaced streets or roadways.	One test per lift for each 500-feet of trench length.
Along unsurfaced roads or in cultivated or landscaped areas.	One test per lift for each 1,000-feet of trench length with at least one test per area.
Under or adjacent to manholes, wetwells, enclosures, boxes, etc.	None, unless geological conditions are inconsistent and requested by the Engineer.

NOTE: The term "test" shall mean a single test with acceptable results, equal to or better than specified minimums. In the event compaction test results fall below the required minimum density; the Contractor shall re-compact and test the material until a test with acceptable results is obtained. Any test failure shall result in additional tests as required by the Engineer, at no cost to the Owner, to ensure that overall project quality objectives are met.

02200.4 METHOD OF MEASUREMENT

02200.4.1 NO MEASUREMENT

02200.4.1.1 TRENCH EXCAVATION AND BACKFILL - Trench excavation and backfill will be considered incidental to other items shown in the Bid Schedule and separate measurement will not be made unless prescribed otherwise in the Contract Documents.

02200.4.1.2 **SOLID ROCK EXCAVATION** - Unless the Contract Bidding Documents contain provisions for "Solid Rock Excavation", no separate measurement or payment will be made for work requiring rock excavation.

02200.4.2 **SPECIFIED SOLID ROCK MEASUREMENT**

When listed as a separate item in the bid schedule, quantities of solid rock excavation shall be determined by the lineal foot unit, using a tape measure or other accurate measuring device to find the length of cut in lineal feet along the plane of cut. This measurement shall include all labor, equipment, materials, and related work, including, but not limited to, ripping, sawing, boring, hammering, blasting, rock trenching, excavating, removing, hauling, and disposal, if required, of the existing bedrock deemed qualified by the Engineer for payment of completed rock excavation.

02200.5 BASIS OF PAYMENT

Separate payment will not be made for trench excavation unless prescribed otherwise in the Contract Documents.

PAYMENT ITEM	UNIT
Solid Rock Excavation	Lineal Foot

SPECIAL PROVISION

TRENCH EXCAVATION AND BACKFILL

**SECTION
SP 02200**

Amend the following sections to include:

02200.4 METHOD OF MEASUREMENT

02200.4.3 PIPE ALIGNMENT PREP EARTHWORK – Pipe Alignment Prep Earthwork will include the effort to prepare the indicated pipe alignment in the Drawings for pipe installation. This is to include excavating over burden down to design grade, filling valleys or depressions to design grade, importing backfill material as needed, removing excess excavated material as needed, and any other earth work required to prepare the pipe alignment for the pipe installation as directed by Spec 2222 and the Drawings. This will be measured as a linear foot of pipe alignment that requires earth prep work by the Engineer and/or the Drawings (primarily delineated as a difference in existing grade and the proposed grade in the pipe installation drawings). This measurement is to include all earthwork outside of the cross-sectional drawings for pipe installation as included in the Drawings.

02200.5 BASIS OF PAYMENT

The accepted quantities shall be paid for at the contract unit price:

PAYMENT ITEM	UNIT
(Pipe Alignment Name) Pre Pipe Installation Earthwork	Linear Feet

02201.1 DESCRIPTION

This section covers furnishing all equipment, labor, and other facilities to excavate, remove, backfill, compact, grade and shape earth materials required for construction of buildings, bridges, retaining walls, head walls, box culverts and other structures, in accordance with the Contract Documents.

02201.1.1 RELATED WORK

Section 01510 - Protection of Existing Properties
Section 02015 - Clearing and Grubbing
Section 02105 - Earthwork Materials
Section 02500 - Removal and Replacement of Surface Improvements
Section 02900 - Landscaping

02201.1.2 SUBMITTALS

Not used.

02201.1.3 DEFINITIONS

Consolidated Backfill - A condition of backfilling for which a specified compaction density is required. Maximum allowable lifts for consolidated backfill under this Section shall be 8 inches unless otherwise approved by the Engineer.

Unconsolidated Backfill - A condition of backfilling for which no compaction density is specified and the required compaction effort is layer placing and then compacting by wheel rolling or use of compacting equipment. Lifts of up to 24 inches are allowed for unconsolidated backfill.

Unclassified Excavation - A determination for excavating whereby no consideration will be given to different kinds of materials that are encountered.

Embankment Fill - The placement and compaction of suitable materials to raise the existing grade to the established elevations, and the placement and compaction of suitable materials within areas where unsuitable materials have been removed. Maximum lift for embankment fill under this Section shall be 6 inches unless otherwise approved by the Engineer.

02201.2 MATERIALS

Not used

02201.3 CONSTRUCTION REQUIREMENTS**02201.3.1 PERMITS**

For work within state or federal highway rights-of-way, the Contractor shall be responsible for obtaining all required encroachment and construction permits prior to beginning any work within the rights-of-way.

02201.3.2 SITE PREPARATION**02201.3.2.1 CLEARING THE SURFACE** - Before proceeding with any ground surface disturbances for work under this Section, the area to be disturbed by excavation, grading or embankments shall be cleared and grubbed in accordance with Section 02015.

- 02201.3.2.2 TOPSOIL - Unless otherwise indicated, the Contractor will not be required to separate, stockpile and replace topsoil on the Work site. When required in the Contract Documents, topsoil shall be removed and stockpiled for later distribution in accordance with Section 02015.
- 02201.3.2.3 REMOVAL OF SUBSURFACE MATERIALS - Following completion of clearing and grubbing, the Contractor shall locate and remove existing underground debris, posts, piping, cables and other underground obstructions. Unless indicated otherwise in the Contract Documents, no separate allowance for costs associated with removal of these materials will be allowed to the Contractor.
- 02201.3.2.4 RELOCATION OF UNDERGROUND UTILITIES - When required by the Contract Documents or determined necessary by the Engineer, existing underground utilities or other objects shall be relocated to provide clearance for required structural components prior to starting any structural excavation.
- 02201.3.3 EXCAVATION
- 02201.3.3.1 UNCLASSIFIED EXCAVATION - All excavation shall be unclassified, unless otherwise indicated in the Contract Documents. The Contractor shall perform all excavation to the elevations and dimensions shown on the Drawings and/or as required to accomplish the Work.
- 02201.3.3.2 CUT SLOPES - Unless otherwise shown on the Drawings, or directed by the Engineer, cut and fill slopes, or cut slopes in soil, shall be no steeper than two horizontal to one vertical. Cut slopes in rock shall be no steeper than 1.5 horizontal to one vertical.
- 02201.3.3.3 STOCKPILING AND DISPOSAL OF EXCAVATED MATERIALS - During the excavation operations, excavated materials which are suitable for use as backfill or embankments around structures, shall be piled separately at sufficient distance from the opening to be out of the way of equipment and to prevent slides or cave-ins.
- All excavated materials not suitable, or not required, for fill or backfill shall be removed promptly from the site of the Work and disposed of in accordance with Section 01520.
- Excavated materials, regardless of their disposition, shall be piled in such manner that will cause the minimum of inconvenience to public travel, and provisions shall be made for emergency travel as necessary.
- 02201.3.3.4 SHORING AND BRACING - Shoring or bracing shall be provided in accordance with OSHA safety requirements on all excavations, to protect workmen and the progression of the Work. In addition, excavation walls shall be braced and supported as required to prevent ground collapse or movement of ground surfaces and structures adjacent to the excavation. Slides or settlements, which occur in the excavation, shall be promptly removed and corrected by the Contractor. The arrangement of shoring and bracing components shall be made so as not to place any stress on portions of completed work.
- 02201.3.4 EXCAVATION IN ROCK
- 02201.3.4.1 SOLID ROCK EXCAVATION - Demonstration of the presence of "solid rock excavation" may constitute a changed condition, and the Contractor will be compensated for removal of such material in accordance with the General Conditions. Before excavation will be considered as "solid rock excavation", the Contractor shall demonstrate an inability to remove rock by making three attempts to rip the rock using equipment having not less than 235 fly wheel horsepower with a "Kelly" or similar type ripper. After such demonstration has indicated the presence of solid rock, and the Engineer determines its removal is necessary, authorization for removal of the solid rock may be granted in accordance with Section 00700.13 of the General Conditions.

02201.3.4.2 **BLASTING** - When blasting is deemed necessary for rock removal, the Contractor shall comply with all applicable State and Local laws, ordinances, and provisions for blasting safety and obtain written approval from the Engineer prior to starting of drilling and/or blasting operations.

In all cases, blasting shall be performed by experienced, qualified blasters. The Contractor is responsible for any and all damage caused by blasting, and blasting will not be allowed within 15 feet of any existing structures.

02201.3.5 **OVER-EXCAVATION**

02201.3.5.1 **UNAUTHORIZED OVER-EXCAVATION** - Care shall be taken not to excavate below the depth required by the Drawings. Any unauthorized over-excavation shall be refilled and compacted with material meeting the requirements of Section 02105 and approved for use by the Engineer at the expense of Contractor.

02201.3.5.2 **UNSTABLE NATIVE FORMATIONS** - The Contractor shall notify the Engineer if soft, spongy, or otherwise unstable native formations, unsuitable for structure foundations, are encountered during excavation. In the event the Engineer determines that such formations are inadequate, the Contractor will be directed to over-excavate and remove the unsuitable materials. The over-excavation shall be backfilled with approved select materials and compacted in accordance with the requirements described herein. Such situation will be considered as a changed condition and the Contractor will be compensated in accordance with the General Conditions.

02201.3.6 **WATER**

02201.3.6.1 **DEWATERING** - The Contractor shall control all ground or surface water during excavation, grading and subsequent construction activities. Dewatering systems shall be provided and operated by the Contractor so as to prevent the removal of the natural soils. Grading shall be performed as necessary to prevent surface water from flowing into excavations. Any water accumulated, therein during construction, shall be promptly removed by pumping or by other approved methods at the Contractor's expense.

Dewatering efforts shall be sufficient to ensure that softening of the bottom of excavations or formation of "quick" conditions or "boils" shall be prevented. Natural or compacted materials within the excavated areas, softened by saturation with ground water or standing surface water, shall be removed and replaced as instructed by the Engineer, at no additional cost to the Owner.

02201.3.6.2 **INSTALLATION IN WATER** - No backfill, subgrade materials, concrete or masonry footings, foundations, floors, equipment, or pipe shall be placed or laid in water. Water shall not be allowed to rise over such work for at least 24 hours following the pour or placement of any concrete or mortar used in the Work. Water shall not be allowed to rise unequally against structure walls for a period of 14 days following concrete placement or masonry erection.

02201.3.6.3 **DISPOSAL** - Any water to be removed from the Work site shall be disposed of by the Contractor in a suitable manner without damage to adjacent property.

02201.3.6.4 **REFERENCE** - See also Section 02200.3.12.

02201.3.7 **SCARIFICATION**

After excavating to the lowest subgrade elevation shown on the Drawings, and prior to placement of the structure footings or foundation components, unless otherwise directed by the Engineer, the top 6 inches of the subgrade shall be scarified, brought to the proper moisture content, and compacted in accordance with the Table of Minimum Density Requirements below.

02201.3.8 EMBANKMENT FILL AND BACKFILL

02201.3.8.1 ON-SITE BACKFILL MATERIALS - Unless directed otherwise by the Engineer or the Contract Documents, on-site materials complying with Section 02105 shall be used for all embankment, fill and backfill materials. Before on-site material becomes unavailable, and when provisions are not included in the Contract Documents for importing suitable materials, the Contractor shall notify the Engineer so that a change can be negotiated in accordance with the General Conditions.

02201.3.8.2 PLACEMENT IN LIFTS - Unless provided otherwise on the Drawings, suitable embankment fill, backfill, and bedding materials shall be placed in lifts which will be not greater than 6 inches thick after compaction. Bedding materials shall be moisture conditioned (by wetting or drying), before being placed in layers for compaction in accordance with the requirements of the Table of Minimum Density Requirements below.

02201.3.8.3 UNSUITABLE FILL AND BACKFILL MATERIALS - Any unsuitable fill and/or backfill material found within excavated materials, or material with incorrect moisture content shall be removed and replaced. Soft spongy material, causing areas that "pump" when heavy loads are passed over them, shall be removed and replaced with suitable material. Dry material that will not "ball" shall be removed and replaced. The two foregoing conditions shall be considered sufficient evidence, without further testing, that the moisture content is incorrect and shall be grounds for removal and replacement of the material. Such replacement if required shall be at the sole expense of the Contractor, and shall be accomplished prior to placement of any further material.

02201.3.9 COMPACTION

02201.3.9.1 MINIMUM DENSITY REQUIREMENTS - After placement, all materials shall be thoroughly compacted to not less than the densities indicated in the table below. Compaction shall be achieved and verified in accordance with AASHTO T-99, ASTM D-1556, ASTM D-1557, ASTM D-2922 and/or ASTM D-3017 as applicable.

**TABLE OF MINIMUM DENSITY REQUIREMENTS
(based on AASHTO-99 and T-91 and on ASTM D-2922 and E-3017)**

Location	From Surface to 2-Feet Below Surface	From 2-Feet Below Surface to Top of Bedding	Bedding
Within 6 feet of, and/or under, any existing or proposed structure, pavement, curb, sidewalk or similar construction included in the Contract:	100% for granular and 95% for non-granular materials	95% for all materials	95% at all locations
Around any structure outside 6 feet:	90% for all materials	90% for all materials	90% at all locations
Cultivated and landscaped areas:	85% for all materials	85% for all materials	85% at all locations
Undeveloped land:	Unconsolidated - see 02201.1.3	Unconsolidated - see 02201.1.3	85% at all locations

- 02201.3.9.2 OTHER SPECIFICATIONS - For work within state or federal highway rights-of-way, compaction shall meet the requirements of the respective applicable specifications.
- 02201.3.9.3 COMPACTION EQUIPMENT - Embankment fill and consolidated backfill material shall be compacted with conventional tamping or vibrating compaction equipment of such capacity and weight to achieve the required compaction density. The use of wheel rolling for compaction shall only be approved for compacting unconsolidated backfill materials.
- 02201.3.9.4 PLACEMENT AGAINST STRUCTURES - Embankment fill or backfilling against cast-in-place concrete structures shall not be started until the concrete has been cured for the time required by these Specifications or prescribed by the Engineer. Compaction within 3 feet of any new or existing structure shall be by hand operated vibratory or tamping equipment.
- 02201.3.9.5 CONSTRUCTION WATER - The Contractor shall be responsible for obtaining construction water needed for compaction in accordance with Section 02204.
- 02201.3.10 SETTLING AND SUBSIDENCE
- Dips or settlement of fill or backfill in any excavation or embankment within the Work, which occur within the warranty period, shall be repaired by the Contractor at no additional cost to the Owner.
- 02201.3.11 SAMPLING AND TESTING
- 02201.3.11.1 INDEPENDENT LABORATORY - The Contractor shall provide all required sampling and testing by an independent qualified testing laboratory as directed by the Engineer.
- 02201.3.11.2 SCHEDULE OF SAMPLING AND TESTING - The following schedule of sampling and testing provides minimum requirements, to assure compliance with all materials and compaction requirements described herein. The number of samples and tests shown shall be considered minimum, and field conditions may necessitate additional sampling and testing to be required by the Engineer.

GRADATION DETERMINATION (AASHTO T-27 and T-11)

Location	Testing Required
Materials imported or manufactured at a site determined by this contract	One test per site or source
On-site excavated materials along trenches	One test per geographical area where material composition and gradation visually appears consistent.

**MOISTURE/DENSITY RELATIONSHIP (Proctor)
(AASHTO T-99 or T-180 Method D)**

Location	Testing Required
Materials imported or manufactured at a site determined by this Contract.	One test per site unless the material visually appears to change.
On-site excavated materials along trenches.	One test per geographical area where material composition visually appears consistent.

**COMPACTION COMPLIANCE TESTING REQUIREMENTS
(AASHTO T-191 or Portable Nuclear Gauges)**

Location	Testing Required
Under Structure footing or foundation	One test per lift for each 100 linear feet.
Within an embankment erected to support a structure under structure floor slabs	One test per lift for each 1,000 square feet.
Within embankments for cultivated or landscaped areas.	One test per lift for each 5,000 square feet.

NOTE: The term "test" shall mean a single test with acceptable results, equal to or better than specified minimums. In the event compaction test results fall below the required minimum density; the Contractor shall re-compact and test the material until a test with acceptable results is obtained.

02201.3.12 GRADING

Upon completion of excavation, the site shall be accurately graded to the spot elevations and slopes shown on the Drawings, to allow proper installation of the structure in accordance with applicable Sections of these Specifications.

02201.4 METHOD OF MEASUREMENT

02201.4.1 NO MEASUREMENT

Separate measurement will not be made for earthwork for structures. Unless the Contract Documents contain provisions for "Solid Rock Excavation", no separate measurement or payment will be made for work requiring rock excavation.

02201.4.2 SEPARATE MEASUREMENT

When listed as a separate item in the Bid Schedule, quantities of solid rock excavation shall be determined by the foot/foot unit, using a tape measure or other accurate measuring device to find the length of cut in lineal feet along the plane of cut and the average depth of cut in the rock and multiplying the two numbers together. This measurement shall include all labor, equipment, materials, and related work, including, but not limited to, ripping, sawing, boring, hammering, blasting, rock trenching, excavating, removing, hauling, and disposal, if required, of the existing bedrock deemed qualified by the Engineer for payment of completed rock excavation.

02201.5 BASIS OF PAYMENT

Payment for earthwork for structures shall be included in the unit prices provided for the respective structure elements listed in the Bid Schedule. When listed as a separate item on the Bid Schedule, payment for "Solid Rock Excavation" will be made as follows:

PAYMENT ITEM	UNIT
Solid Rock Excavation	Foot/Foot

02202.1 DESCRIPTION

This section covers construction of roadways and embankments, roadway ditches, channel changes, furrows, slope rounding, benches, berms, dips, approaches, and subsidiary work.

02202.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 02208 – Flowable Backfill (required during winter months)

02202.1.2 SUBMITTALS

Not used.

02202.1.3 DEFINITIONS

Roadway - The graded portion of a road within the top of cut slopes and the toe of embankment slopes, excavated and placed to form a surface for vehicular travel.

Excavation - That portion of the roadway which is removed from its original position and deposited within the roadway as embankment.

Embankment - Excavated earth materials moved from an original source and placed within the roadway.

Unsuitable Material - Excavated earth materials determined by the Engineer to be unsuitable for placement in roadway embankment. Such materials may include rock too large for placement in embankment, topsoil containing excessive vegetative debris, unstable earth materials, etc.

Roadbed - That portion of the roadway graded to the surface upon which vehicles travel, including the shoulders.

Subgrade - The graded roadbed finished according to the details shown on the Drawings and prepared to receive surfacing when called for on the Drawings.

Borrow - Earth materials excavated from a designated source, outside the roadway, and placed in embankments within the roadway. Designated sources for borrow material shall be shown on the Drawings or elsewhere described in the Contract Documents, and shall be approved by the Engineer prior to being placed in embankment.

Pioneering - The beginning or opening of a route on which a roadway is to be constructed prior to clearing or starting any earthwork excavation.

Structure Excavation - Excavation, backfill and/or disposal of material required in the roadway for construction of culverts, bridge foundations or other structures.

Cushion - Soil materials placed over rocks or solid rock portions of the roadway to provide a gradable surface. Cushion materials shall not contain rocks large than one-third of the minimum thickness of the cushion layer.

02202.2 MATERIALS

Not used.

02202.3 CONSTRUCTION REQUIREMENTS

This Work shall consist of furnishing all labor, equipment and materials for constructing a roadway, including borrow excavation, drainage excavation, removal of slide material, excavation of unsuitable material, embankment construction and disposal of all excavated material necessary for the completion of construction.

02202.3.1 CLEARING AND GRUBBING

Clearing and grubbing shall be accomplished in accordance with Section 02015 before any excavation or embankment begins, except that grubbing of stumps when approved by the Engineer may proceed concurrently with excavation, and the removal or burning of cleared debris may be delayed until weather permits. Excavation and placement operations shall be conducted so material to be treated under Section 02015 will not be incorporated in the roadway.

02202.3.2 PIONEERING

Pioneering operations for the top of excavation slopes, toe of embankments, or pioneer road construction shall be accomplished to prevent undercutting of the final excavation slope, depositing of materials outside of the roadway limits and any restriction of drainage.

02202.3.3 UTILIZATION OF EXCAVATED MATERIALS

All suitable excavated material shall be used in the construction of embankments, subgrades, shoulders, slopes, bedding and backfill for structures and for other purposes as shown on the Drawings and as described below:

02202.3.3.1 EXCESS EXCAVATION - Designed excess excavation shall be disposed of as shown on the Drawings.

02202.3.3.2 ROCK FOR SLOPE PROTECTION - When approved by the Engineer, excavated rock suitable for protection of embankments may be conserved and used in lieu of a designated materials source.

02202.3.3.3 CONSERVING MATERIAL - Material encountered in the excavation, suitable for cushion, road finishing or other purposes, may be conserved and utilized instead of materials from designated sources.

02202.3.3.4 EXCAVATION OF UNSUITABLE MATERIAL - Unsuitable material shall be excavated. Disposal will be as shown on the Drawings. Excavated areas shall be backfilled with suitable material when necessary to complete the Work. Frozen material shall not be placed in embankments. Rocks that are too large to be incorporated into the embankment shall be broken for incorporation into the embankment or maneuvered to the face of the embankment and embedded so that they will not roll or obstruct the use and maintenance of the roadbed, or moved to locations approved by the Engineer.

02202.3.3.5 CONSERVATION OF TOPSOIL - When indicated on the Drawings, suitable topsoil shall be removed, transported, and deposited in the designated stockpile areas.

02202.3.3.6 ABANDONED STRUCTURES AND OBSTRUCTIONS - Abandoned structures and obstructions shall be treated in accordance with Section 02500.

02202.3.4 DRAINAGE EXCAVATION

Drainage excavation shall include construction of side ditches, minor channel changes, inlet and outlet ditches, furrow ditches, ditches constructed along the road but beyond the roadway limits and

other minor earth drainage structures as shown on the Drawings. Excavated material shall be utilized in accordance with subsection 02202.3.3 above.

02202.3.5 **FINISHING ROADBED**

02202.3.5.1 **OVERSIZE MATERIALS** - For roads receiving aggregate base or surface course, only rocks that do not protrude above the subgrade more than one-third of the depth of the base or surface course or 3-inches, whichever is less, may remain in place.

For unsurfaced roads, unless otherwise shown on the Drawings, the top 4-inches below the finished road surface shall not contain rocks larger than 4-inches in greatest dimension. Oversize material shall be removed, reduced to acceptable size or covered by importing suitable material approved by the Engineer.

02202.3.5.2 **SHAPING AND DRESSING** - The subgrade shall be visibly moist during shaping and dressing. Low sections, holes, cracks or depressions shall be brought to grade with suitable material approved by the Engineer. Final compaction of the subgrade shall meet the requirements of the embankment placing method specified.

02202.3.6 **SNOW REMOVAL**

Snow and/or ice shall not be incorporated into the embankment. Snow shall be removed in advance of the work to be performed and shall be deposited beyond the roadway limits in a manner that will not result in erosion or waste material.

02202.3.7 **FINISHING SLOPES**

02202.3.7.1 **SLOPE SURFACE** - Slopes shall be finished as closely as is practicable to the lines staked on the ground or shown on the Drawings. The finished slope shall be left in a slightly roughened condition to facilitate the establishment of vegetative growth. The finish associated with template and stringline or hand-raking methods will not be allowed. Loose rock, loose debris and other loose material, each of which is large than 6-inches in diameter, shall be removed from the slope unless otherwise shown on the Drawings.

02202.3.7.2 **SLOPE TOP** - The tops of excavations, excluding areas of solid rock, shall be blended with the adjacent terrain by rounding when shown on the Drawings. Decomposed rock that may be cut without blasting or ripping shall be rounded. Earth overlying rock shall be rounded above the rock.

02202.3.8 **BLASTING**

02202.3.8.1 **CONTROLLED BLASTING** - All rock excavations that require blasting shall be formed with controlled blasting techniques unless otherwise shown on the Drawings. Controlled blasting is defined as the controlled usage of explosives and blasting accessories in appropriately aligned and spaced drill holes for the purpose of producing a free surface or shear plane in the rock excavation slopes and of minimizing landscape damage, adjacent ground vibration and overbreak. Presplitting is not intended unless shown on the Drawings and described in the Contract Documents.

02202.3.8.2 **TEST SECTIONS** - Unless directed otherwise by the Engineer, the Contractor shall drill, blast and excavate short test sections (not to yield in excess of 1,000 cubic yards) to determine the controlled blasting method, hole spacing and charge best suited to the material encountered.

02202.3.9 **OVERBUILDING**

Unless otherwise agreed to by the Engineer, excavation or embankment material shall be confined within the roadway limits to avoid overbuilding and to protect the adjacent property.

02202.3.10 SUBGRADE TREATMENT

02202.3.10.1 TREATMENT MATERIALS - Subgrade treatment shall consist of soil modification by mixing aggregates, placing geotextiles, fiber mat, rock blanket or other similar materials over areas of unsuitable embankment foundation material that will be indicated on the Drawings. The construction and material requirements for the subgrade treatment will be specified in the Contract Documents.

02202.3.10.2 SWAMPY GROUND - When an embankment is to be placed across swampy ground and removal of unsuitable material or subgrade treatment is not required, the lower part of the embankment may be constructed in a single layer to the minimum depth necessary to support construction equipment.

02202.3.11 EMBANKMENT PLACEMENT

All embankments shall be placed by one or more of the following methods as shown on the Drawings and listed in the Bid Schedule.

02202.3.11.1 METHOD 1 - SIDE CASTING AND END DUMPING - Embankment may be placed by side casting and end dumping. Where material containing a large amount of rock is used to construct embankments, a solid embankment shall be provided by working smaller rocks and fines in with the large rocks and fines to fill the voids.

02202.3.11.2 METHOD 2 - LAYER PLACEMENT - Surfaces steeper than a ratio of 3 horizontal to 1 vertical (3:1) upon which embankment is to be placed, shall be roughened or stepped when shown on the Drawings to provide permanent bonding of new and old materials.

- Embankment shall be layer placed, except over rock surfaces, in which case material may be placed by end-dumping to the minimum depth needed for operation of spreading equipment. Each embankment layer shall be leveled and smoothed before placement of subsequent layers. Hauling and spreading equipment shall be operated uniformly over the full width of each layer.
- Suitable material shall be placed in layers no more than 12-inches thick, except when the material contains rock more than 9-inches in diameter, in which case layers may be of sufficient thickness to accommodate the material involved. No layer shall exceed 24-inches before compaction.
- Placing individual rocks or boulders greater than 24-inches will be permitted provided the embankment will accommodate them. Such rocks and boulders shall be at least 6-inches below subgrade. They shall be carefully distributed and the voids filled with finer material to form a dense and compacted mass.
- Where material containing large amounts of rock is used to construct embankments, the layers may be of sufficient thickness to accommodate the material involved. A solid embankment with adequate compaction shall be constructed by working smaller rock and fines in with the larger rocks to fill the voids and by operating hauling and spreading equipment uniformly over the full width of each layer as the embankment is constructed.
- Material shall be at a moisture content suitable to obtain a mass that will not visibly deflect under the load of the hauling and spreading equipment. Excessively wet excavated material shall be handled in accordance with Subsection 02202.3.3.1.

02202.3.11.3 METHOD 3 - LAYER PLACEMENT (ROLLER COMPACTION) - Embankments shall be placed as specified in Method 2. Placement shall be in horizontal layers not exceeding 12-inches prior to compaction, except when the material contains rock more than 9-inches in diameter, in which case layers may be of sufficient thickness to accommodate the material involved. Compaction shall be

obtained with equipment in compliance with the requirements described in the Specifications. Compaction equipment shall be operated over the full width of each layer until visible deformation of the layer ceases or, in the case of the sheepsfoot roller, the roller "walks out" of the layer. At least three complete passes will be made.

02202.3.11.4 **METHOD 4 - CONTROLLED COMPACTION** - Embankments shall be placed as specified in Method 2 except earth embankments shall be placed in horizontal layers not exceeding 12-inches (loose measure) and compacted. Material shall be at a moisture content suitable for attaining the required compaction. Embankments and the top 1-foot of excavation sections shall be compacted to at least 95 percent of the maximum density as determined by AASHTO T 180, Method C or D.

- The density of the embankment material shall be determined during the progress of the Work in accordance with AASHTO T 191, T 205 or T 238; T 217, T 239 or T 255; and T 224.
- Density requirements will not apply to portions of rock embankments that cannot be tested in accordance with approved methods. When this condition exists, compaction shall be provided by working smaller rocks and fines in with the larger rocks to fill the voids and by operating equipment over the embankment materials.

02202.3.12 **COMPACTION EQUIPMENT**

02202.3.12.1 **EQUIPMENT** - Compaction equipment shall be capable of obtaining compaction requirements without detrimentally affecting the compacted material. The compacting units may be any one of the types described herein, provided they are capable of compacting each lift of material as specified and meet the minimum requirements contained herein.

02202.3.12.2 **ROLLER REQUIREMENT** - Minimum requirements for rollers are as follows:

- Sheepsfoot, tamping or grid rollers shall be capable of exerting a force of 250 pounds per inch of width of roller drum.
- Steel-wheel rollers, other than vibratory, shall be capable of exerting a force of not less than 250 pounds per inch of width of the compression roll or rolls.
- Vibratory steel-wheel rollers shall have a minimum weight of 6 tons. The compactor shall be equipped with amplitude and frequency controls and specifically designed to compact the material on which it is used.
- Pneumatic-tire rollers shall have smooth tread tires of equal size that will provide a uniform compacting pressure for the full width of the roller and capable of exerting a ground pressure of at least 80 psi.

02202.3.13 **CONSTRUCTION TOLERANCES**

Unless provided otherwise herein, a specific tolerance class for allowable deviation from construction stakes and Drawings shall be shown on the Drawings. A Table of Tolerance is provided below:

TABLE OF TOLERANCES

MEASUREMENT	TOLERANCE CLASS		
	A	B	C
Roadbed Width	+0.5	+1.0	+2.0
(feet) Subgrade Elevation	+0.1	+0.2	+0.5
(feet) Centerline Alignment	+0.2	+0.5	1.0

Deviations shall be uniformly graded in the direction of change for a distance of 200-feet or more along the roadway. Roadway ditches shall always be constructed to flow in the direction shown on the Drawings, regardless of allowable deviations. Roadbed width shall be no less than the dimension shown on the Drawings or staked in the field. When a tolerance class is not otherwise indicated on the Drawings, Class B tolerance deviations will be allowed for roadway construction.

02202.3.14 WATER

Water provided for compaction, dust control, or planting and care of vegetation, shall be developed, hauled and applied in accordance with Section 02204.

02202.4 METHOD OF MEASUREMENT**02202.4.1 ROADWAY EXCAVATION**

02202.4.1.1 SEPARATE MEASUREMENT - When shown as a separate item on the Bid Schedule, quantities of roadway excavation, in cubic yards, shall be determined, for undisturbed material in its original position on the ground, as measured by slope staking performed before the start of construction. Unless shown otherwise herein, measurement for roadway excavation shall include the following:

- All loosening, loading, transportation, spreading, compaction and grading required to achieve the staked grades and alignment.
- Material excavated below the required grade and beneath embankment areas when shown on the Drawings or directed by the Engineer.
- Ditches located outside of the roadway, except when they are included as an item on the Bid Schedule.
- Topsoil or other material removed and stockpiled as directed, when not measured as a separate pay item.
- Borrow material used in the Work, except when borrow is included in the Bid Schedule.
- Slide material not attributable to the negligence of the Contractor.
- The volume of materials taken from stockpiles and used in the Work, except materials included in other pay items.

02202.4.1.2 NO MEASUREMENT - Measurement for roadway excavation shall not include the following:

- Material used for other than approved purposes.
- Unauthorized excavation or borrow.
- Quantity of material excavated from slope rounding.
- Overbreakage from the backslope in rock excavation requiring blasting.
- Material scarified in place to receive the first layer of embankment.
- Benching or stepping existing ground for embankment foundation.
- Stepping or scaling cut slopes.

- Oversize material removed when finishing unsurfaced roads.

02202.4.2 ROADWAY EMBANKMENT

When shown as a separate item in the Bid Schedule, measurement of quantities for roadway embankment will be by the cubic yard as determined from slope stake information taken prior to construction, for materials in place, compacted, and accepted.. Unless shown otherwise herein, measurement shall include all loosening, loading, transportation spreading, compaction and grading required to achieve the staked grades and alignments.

02202.4.3 ROADWAY BORROW

When shown as a separate item in the Bid Schedule, quantities for roadway borrow, calculated in cubic yards, shall be measured by. comparing preliminary cross-sections of the material on the undisturbed ground to other cross sections taken following its removal. Measurement shall include all loosening, loading and transportation to the location of the embankment designated for deposit.

02202.4.4 WATER

02202.4.4.1 NO SEPARATE MEASUREMENT - Unless shown as a separate item in the Bid Schedule, no separate measurement shall be made for water required for compaction, handling or other purposes associated with earthwork excavation and embankment.

02202.4.4.2 SEPARATE MEASUREMENT - When included as a separate item, measurement will be made in accordance with Section 02204.

02202.4.5 TOPSOIL

When topsoil stripping and stockpiling is included as a separate item in the Bid Schedule, measurement will be by the cubic yard placed in stockpiles at designated locations shown on the Drawings or directed by the Engineer. Measurement shall include loading, transportation and placement into stockpiles at designated locations.

02202.4.6 TOPSOIL SPREADING

When topsoil spreading is included as a separate item in the Bid Schedule, measurement will be by the square yard of surface on which the material is spread at a depth indicated in the Drawings. Such measurement shall include loading from a stockpile or designated source, transporting and spreading to the required depth.

02202.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
Roadway Excavation (Placement Method)	Cubic Yard
Roadway Borrow (Placement Method)	Cubic Yard
Roadway Embankment (Placement Method)	Cubic Yard
Subgrade Treatment (Type)	Square Yard
Drainage Excavation (Type)	Lineal Foot
Drainage Excavation (Type)	Cubic Yard
Topsoil (Stripped & Stockpiled)	Cubic Yard
Topsoil (Spread)	Square Yard

02203.1 DESCRIPTION

Work under this section shall include complete construction of a pond, dike, or system of ponds for containment of water as specified herein. The work of this section shall include excavation and grading, embankment placement, trenching and backfilling, roadway construction and subsidiary work, and disposal of excess excavated material as required to complete construction of the ponds.

To aid in the design of ponds, a geotechnical engineering consultant may be employed by the Owner or the Engineer to investigate the soils on the site for the purpose of evaluating subsurface conditions and for making recommendations for their utilization in construction. If this work has been done, a copy of the geotechnical report is included as an exhibit to the Contract.

02203.1.1 RELATED WORK

Section 01510 - Protection of Existing Properties
Section 01520 - Environmental Controls
Section 01560 - Construction Staking
Section 02015 - Clearing and Grubbing
Section 02105 - Earthwork Materials
Section 02200 - Trench Excavation and Backfill
Section 02204 - Water for Construction

02203.1.2 SUBMITTALS

Not used.

02203.1.3 DEFINITIONS

Ponds - Include reservoirs, lagoons, dikes, or any earth structures constructed for holding water or wastewater.

Excavation - Earth materials removed from their original position to form the configuration of pond components and subsidiary earth structures shown on the Drawings.

Embankment - Excavated materials obtained on the Work site and placed in configurations shown on the Drawings to form pond components and subsidiary earth structures.

Subgrade - The surface of embankment or excavated areas graded according to the details shown on the Drawings and prepared to receive a liner or other covering layer.

Unsuitable Material - Excavated materials determined by the Engineer to be unsuitable for placement in embankments. Such materials may include rock too large for placement in embankment, soil containing excessive vegetative debris, soils with excessive permeability, unstable earth materials, etc.

Borrow - Earth materials imported to the site of the pond construction from sources outside the Work site.

Unclassified Material - Excavated materials for which no classification has been made to establish different, or separate, prices for their excavation or placement in the Work.

Clay Liner - Earth or other materials installed in the pond to form a surface which restricts or prevents water seepage from the pond bottom and banks.

Cushion - Earth material installed as a protective layer between defined earth or structural components.

02203.2 MATERIALS

02203.2.1 EARTH MATERIAL

Shall meet the requirements provided herein and prescribed in other referenced sections of these Specifications.

02203.2.2 CLAY LINERS

Clay material obtained on site, or from off-site sources approved by the Engineer, having a permeability of less than 1.0×10^{-6} cm/sec. Clay material shall be moisture conditioned to optimum conditions for placement and shall not contain particles greater than 1/2-inch diameter. Minimum liquid limit shall be 30.

02203.2.3 NON-CLAY LINERS

Non-clay liners shall be materials meeting the requirements provided in the Contract Documents and shown on the Drawings.

02203.2.4 PIPING AND OTHER STRUCTURAL MATERIALS

Shall meet the configuration and requirements shown on the Drawings, other referenced sections of these Specifications, and the Contract Documents.

02203.2.5 ON-SITE MATERIALS

Materials encountered during excavation and determined by the Engineer to be suitable for use in the Work; they should be conserved and utilized in lieu of materials from off-site sources.

02203.2.6 WATER

Water used for construction shall be developed, hauled and applied in accordance with Section 02204.

02203.3 CONSTRUCTION REQUIREMENTS

02203.3.1 REGULATORY REQUIREMENTS OF WASTEWATER LAGOON CONSTRUCTION

The construction of wastewater lagoon systems shall meet or exceed all applicable requirements for wastewater facility construction of the state in which the system is being constructed.

02203.3.2 CONSTRUCTION STAKING

Staking for locating and for initiating construction of ponds and their subsidiary components shall be provided in accordance with Section 01560. Additional staking determined necessary by the Contractor shall be provided by the Contractor.

02203.3.3 DEWATERING

Where the ground water is higher than 2 feet below the finished pond bottom grade, the first construction operation at the lagoon site shall be to install the drain system. The drain system shall include all drain trenches, drain gravel, perforated pipe, manholes, drain waste pipe, and drain

discharge end sections, as shown on the Drawings. When required by local regulations, piezometers will be installed by the Engineer at random locations throughout the site. No other construction, with the exception of clearing and grubbing, may take place until the site has been sufficiently de-watered. When ground water has subsided to 2-feet below the finished pond bottom grade, the Contractor may proceed with earthwork operations.

02203.3.4 CLEARING AND GRUBBING

The Contractor shall completely clear and grub the entire site within the boundary of the pond or lagoon dikes in accordance with Section 02015 before any excavation or embankment begins. This operation shall include removal of the first 6 inches of organic laden top soil, which shall be stockpiled for later use as a protective layer over the clay liner of each pond or lagoon bottom.

02203.3.5 EXCAVATION

The Contractor shall provide all necessary equipment, materials and labor required to construct ponds to the neat lines and finished grades shown on the Drawings.

02203.3.5.1 SEGREGATION AND STOCKPILING - As part of the excavation operation, the Contractor shall stockpile excavated materials into select categories as required herein. Excavated silt/clay material shall be separated from the sands and gravels and placed in individual stockpiles to be used later for embankment and liner construction. Soils with the highest clay content (CL and CL - ML soil types) shall be further separated from the remaining sandy silt soils (ML soils) for reuse specifically as liner material when a clay liner is required by the Contract Documents.

02203.3.5.2 TESTING FOR SOIL CHARACTERISTICS - Due to the inherent variability in the occurrence of soil types, it is required that frequent inspection, sampling and testing be performed during construction. This is necessary to verify that actual material properties (primarily permeability and compaction) are consistent with those projected from preliminary investigation and recommendations in the geotechnical report.

02203.3.5.3 SITE INVESTIGATION FOR CLAY LINER MATERIAL - When a clay liner is required, the Contractor shall investigate the extent of occurrence of granular soils across the entire wastewater lagoon bottom area. This shall be accomplished by excavating shallow test pits to a depth of 18-inches below the level of the bottom of the liner in a 50-foot (minimum) grid pattern. Wherever granular soils are encountered at a depth of less than one foot below the bottom of the planned liner, the soils shall be excavated and replaced to ensure a minimum one-foot thick blanket of fine-grained soil beneath the clay liner. The granular soils removed shall then be replaced to the level of the bottom of the liner with fine-grained silt or clay soils; moisture conditioned and compacted as required in this Section.

02203.3.5.4 CONDITIONING OF SOILS - Exposed soils inside the pond area shall not be allowed to dry out and crack. If drying and cracking of those soils occurs, the material shall be re-scarified, moisture conditioned to the recommended value and recompacted. As an alternative, any dried or cracked soils may be removed and replaced with properly conditioned, approved materials with an acceptable moisture content.

02203.3.5.5 UNAUTHORIZED OVER-EXCAVATION - Care shall be taken to avoid excavation beyond Drawing requirements. Any unauthorized over excavation shall be repaired at the expense of Contractor, and as directed by the Engineer, using materials meeting requirements of Section 02105.

02203.3.5.6 WASTING OF EXCESS MATERIALS - Excess excavated materials may be wasted on the exterior of pond dikes, when approved by the Engineer; however, such waste area shall be finished similarly to the dike slope.

02203.3.5.7 **REMOVAL AND DISPOSAL OF EXCESS AND UNSUITABLE MATERIALS** - Other methods of excess material disposal shall be as directed by the Engineer. Unsuitable material shall be removed and disposed of in accordance with the Contract Documents or as directed by the Engineer. Areas from which unsuitable materials have been removed, shall be backfilled and compacted with suitable material as necessary to complete the Work and as directed by the Engineer.

02203.3.5.8 **FROZEN MATERIALS** - Snow, ice, or other frozen material shall not be placed in the Work. If a snow event should occur during construction of the pond or lagoon, the snow shall be removed and deposited outside the pond area prior to resuming construction.

02203.3.6 **ROCK EXCAVATION**

02203.3.6.1 **CHANGE IN THE WORK** - Unless shown otherwise in the Contract Documents, all excavation shall be considered unclassified and no separate measurement or payment will be authorized for work requiring rock excavation unless a changed condition is determined by the Owner and Engineer.

02203.3.6.2 **SOLID ROCK EXCAVATION** - If the Owner and Engineer determine a changed condition for rock excavation is necessary; the Contractor shall be compensated for removal of such material in accordance with the provisions of the General Conditions. A changed condition may be determined if significant unforeseen solid rock is encountered and the Contractor demonstrates an inability to remove rock after making three attempts to rip the rock using equipment having not less than 235 fly wheel horsepower and equipped with a "Kelly" or similar type ripper. If it is determined a changed condition, excavation of such material will be considered as "Solid Rock Excavation" and such demonstration shall constitute a changed condition.

02203.3.6.3 **BLASTING** - When blasting is deemed necessary for rock excavation, the Contractor shall comply with all applicable State and Local laws, ordinances, and provisions for blasting safety and obtain written approval from the Engineer prior to starting of drilling and/or blasting operations.

In all cases, blasting shall be performed by experienced, qualified blasters. The Contractor is responsible for any and all damage resulting from blasting. Blasting will not be approved within 15 feet of any existing structure.

02203.3.7 **COMPACTION**

02203.3.7.1 **ROLLER REQUIREMENTS** - Compaction equipment shall be any one of the types listed below, with the minimum characteristics shown for each type:

- Sheepfoot, tamping or grid rollers, capable of exerting a force of 250 pounds per inch of width of roller drum.
- Steel-wheel rollers, capable of exerting a force of not less than 250 pounds per inch of width of the roller drum.
- Vibratory steel-wheel rollers, with a minimum weight of 6 tons. Such compactors shall be equipped with amplitude and frequency controls.
- Pneumatic-tire rollers, with smooth tread tires of equal size that will provide a uniform compacting pressure for the full width of the roller and capable of exerting a ground pressure of at least 80 psi.

02203.3.7.2 **OPERATION** - Compaction equipment shall be operated over the full width of each layer until visible deformation of the layer ceases or, in the case of the sheepfoot roller; the roller "walks out" of the layer. A minimum of three passes shall be made over the entire area of compaction regardless of the type of compaction equipment used.

02203.3.8 POND EMBANKMENTS

02203.3.8.1 **PLACEMENT** - Pond or lagoon dike embankments shall be layer placed in loose horizontal lifts not exceeding 8 inches thick prior to compaction. Embankments and the top 12-inches of excavation sections shall be brought to slightly above optimum moisture content and compacted to a minimum of 90 percent of the maximum dry density as determined by the AASHTO T-180.

02203.3.8.2 **UTILIZATION OF FINE GRAINED MATERIALS** - Fine-grained soils are intended to be utilized on the inside surfaces of the pond bottoms and dike surfaces. Where sufficient fine-grained materials are not available on site for utilization throughout embankments, granular soils may be used to complete the outward one third of the dike embankments. No separate measurement and payment for such utilization will be allowed unless provided otherwise in the Contract Documents.

02203.3.9 FINISHING EARTHWORK SURFACES

Excavated and embankment surfaces shall be uniformly graded and finished in conformance to the lines and grades shown on the Drawings. When completed, the average plane of the slopes shall conform to the construction tolerances provided in this Specification. The tops of excavation slopes and the ends of excavations shall be trimmed to remove any overhang or rounded when shown on the Drawings.

02203.3.10 PREPARATION FOR CLAY LINER

02203.3.10.1 **SUBGRADE PREPARATION** - When excavation of the pond bottom is achieved to subgrade, the Contractor shall scarify and loosen the top 6 inches of the subgrade surface through the use of conventional disking, forking or other means. The subgrade surface shall then be evenly graded with rough and fine grading and leveled to the lines, grades, and elevations shown on the Drawings. Subgrade shall then be compacted to 90 percent of the maximum density as determined by AASHTO Method T-180.

02203.3.10.2 **ENGINEER APPROVAL** - Before the Contractor proceeds with installation of the clay liner, the subgrade surface shall be examined and approved by the Engineer.

02203.3.11 CLAY LINER CONSTRUCTION

02203.3.11.1 **MATERIALS** - Only clay materials having a permeability of less than 1.0×10^{-6} cm/sec from the lagoon excavation shall be used for clay linings. Remove rocks, debris, vegetation and other detrimental material from the clay material as directed by the Engineer during construction.

02203.3.11.2 **MIXING** - Clay liner material shall be thoroughly mixed, scarified, blended, processed, disked, or rotomixed to provide a uniform content and gradation throughout the placement operations.

02203.3.11.3 **MOISTURE CONTENT** - During mixing, clay liner material shall be moisture conditioned. It shall be brought to within 2 percent (+ or -) of the optimum moisture content before spreading and compaction is started. Any dried clay soils containing particles (clods) larger than 1/2-inch shall be reprocessed and moisture conditioned to eliminate particles of greater sizes prior to placement. If the moisture content in the stockpiled material is higher than permissible limits, disk the soil and allow to air dry before placing.

If drying and cracking occur in the liner before the Engineer has issued final acceptance of the Work, the material shall be scarified, moisture conditioned to the recommended value, and re-compacted. As an alternative to re-scarification and re-compaction, any dried or cracked liner material may be removed and replaced with new liner materials.

02203.3.11.4 **PLACEMENT** - Placement of the clay liner shall be made in at least two separate lifts, 6" maximum compacted thickness. The first lift shall be completely installed, compacted and verified before the second lift is started.

Each lift shall be uniform using scrapers, dozers, motor graders, or similar and manipulated until the desired thickness is achieved and significant humps, swales, windrows, and ridges are removed.

02203.3.11.5 **CLAY LINER COMPACTION**

- **Compaction Equipment.** The compactor shall be a static smooth drum roller either self-propelled or towed. Use hand-held mechanical compactors or tampers on difficult areas, which are inaccessible or impractical for large compacting equipment.
- **Compaction Process.** Liner material shall be compacted to a minimum of 90 percent of the maximum dry density as determined by the AASHTO T-180. If there is a break in the compaction operation of more than 24 hours, scarification of at least 2 inches in depth is required.

02203.3.12 **CONSTRUCTION TOLERANCES**

Unless provided otherwise in the Drawings or Contract Documents, the tolerance for allowable deviation from construction staking requirements shall be as shown in the table below:

CONSTRUCTION TOLERANCES

Measurement	Tolerance
Bank Top Width (feet)	Not less than dimensions shown on the Drawings and not more than one (1) foot.
Subgrade Elevation, Line and Grade (feet)	+0.2
Clay Liner Elevation, Line and Grade (feet)	+0.2
Clay Liner Thickness (feet)	+0.2 - 0.0
Deviation of Slope Plane Surfaces	Not more than 6-inches measured perpendicular to the slope surface

02203.3.13 **TESTING AND QUALITY CONTROL**

02203.3.13.1 **TESTING SERVICE** - The Contractor shall be responsible for soils and compaction testing during construction. The Contractor shall obtain the Engineer's approval of the selected testing service provider at least ten (10) days before pond excavation and/or embankment placement is started. Approval of the Contractor's testing service provider shall be based on a statement of qualifications, which shall be submitted to the Engineer.

02203.3.13.2 **PERMEABILITY TESTING** - Permeability testing shall be done by single ring infiltrometer (SRI) tests performed in-situ. SRI's shall be performed on each lift of liner materials at random locations selected by the Engineer. Two SRI tests shall be performed for each lift in treatment lagoon cells, and three SRI tests shall be performed for each lift in storage lagoon cells. Sufficient time shall be allowed to be sure that each lift of the clay liner passes the required tests before construction of subsequent lifts begins. If a test fails, immediate retests shall be conducted, at which time the Engineer shall direct the Contractor on further proceedings.

02203.3.13.3 **COMPACTION TESTING** - Compaction testing shall conform to ASTM D-1557. A new test shall be prepared for every change in soil type. Compaction shall be tested at the rate of one test for every 21,000 square feet of compacted material surface area, or as directed by the Engineer. The locations of compaction tests shall be selected at random by the Engineer. Each liner or embankment lift shall be tested to assure proper compaction prior to placement of any subsequent lift.

02203.3.13.4 **FAILURE TO MEET TESTING REQUIREMENTS** - Areas of embankments, subgrades or liner, which fail to meet compaction testing requirements, shall be scarified, brought to the proper moisture content and recompacted until tests results show compliance. Reworked areas shall be retested until they meet project requirements. Rework and retesting required as a result of any failed test shall be performed at the sole expense of the Contractor.

Areas of clay liner that fail to meet permeability requirements shall be removed and replaced with suitable clay liner materials. Additional tests shall be performed at the direction of the Engineer and at the expense of the Contractor, to ensure that permeability requirements are met for the liner. Reworked areas shall be retested until they meet project requirements.

02203.4 METHOD OF MEASUREMENT

02203.4.1 LUMP SUM

Measurement for pond, dike, or lagoon construction shall be by the lump sum. Measurement shall include all excavation, segregation, spreading, fill, dike or embankment construction, and all other work necessary to complete the pond or lagoon to the lines, grades, elevations and dimensions shown on the Drawings.

Notwithstanding the foregoing, the Engineer shall calculate the total cubic yards of compacted embankment in place to the neat lines shown on the plans. A construction note on the plans shall indicate this yardage along with the shrink factor used to balance the excavation (cut) with the embankment (fill) and, if applicable, the yardage of import or export. This information is provided to assist the Contractor in understanding the scope of work; however, the Contractor shall ascertain for itself the work required to complete the Project and shall base its bid correspondingly.

02203.4.2 NO MEASUREMENT

Unless identified in the Bid-Schedule, inlet structures, outlet structures, transfer structures and level indicators shall be included in pond or lagoon construction, and no separate measurement shall be made for these items. When identified in the Bid-Schedule, measurement for inlet structures, outlet structures, transfer structures and level indicators shall be by the units identified in the Bid-Schedule.

02203.4.3 SEPARATE MEASUREMENT

02203.4.3.1 **RIPRAP** - Quantity of riprap shall be determined in the field using a tape measure or other accurate measuring device to find the length and width of liner in place and accepted. The length shall be multiplied by the width and by the minimum depth shown on the Plans to determine the volume to be converted to cubic yards.

02203.4.3.2 **CLAY LINER** - Quantity of clay liner shall be determined in the field using a tape measure or other accurate measuring device to find the length and width of liner in place and accepted. The length shall be multiplied by the width and by the minimum depth shown on the Plans to determine the volume to be converted to cubic yards.

02203.4.3.3 **SOLID ROCK EXCAVATION** - When listed as a separate item in the bid schedule, quantities of solid rock excavation shall be determined by the foot/foot unit, using a tape measure or other accurate measuring device to find the length of cut in lineal feet along the plane of cut and the average depth of cut in the rock and multiplying the two numbers together. This measurement shall include all labor, equipment, materials, and related work, including, but not limited to, ripping, sawing, boring, hammering, blasting, rock trenching, excavating, removing, hauling, and disposal, if required, of the existing bedrock deemed qualified by the Engineer for payment of completed rock excavation.

02203.5 BASIS OF PAYMENT

When identified in the Bid-Schedule, accepted quantity(s) will be paid for at the contract unit rate for:

PAY ITEM	UNIT
Pond or Lagoon Construction	Lump Sum
Inlet Structure	Each
Outlet Structure	Each
Transfer Structure	Each
Level Indicator	Each
Rip Rap	Cubic Yard
Clay Liner	Cubic Yard
Solid Rock Excavation	Cubic Yard

SPECIAL PROVISION

EARTHWORK FOR PONDS AND DIKE CONSTRUCTION

**SECTION
SP 02203**

Amend the following sections to include:

02203.4 METHOD OF MEASUREMENT

0203.4.3.4 OVERFLOW DITCH - Quantities of Overflow ditch shall be determined linear feet, calculated by neat line dimensions down the centerline of the ditch alignment shown on the drawings. Rock check dams are considered incidental to the linear feet of Overflow Ditches installed.

02203.5 BASIS OF PAYMENT

The accepted quantities shall be paid for at the contract unit price:

PAYMENT ITEM	UNIT
Overflow Ditch	Linear Feet

02204.1 DESCRIPTION

Furnish and apply water for: dust control, pre-wetting, mixing or compacting earth materials for road, site, and/or trench construction, and for other needs associated with the Work.

02204.1.1 RELATED WORK

Not used.

02204.1.2 SUBMITTALS

Not used.

02204.1.3 DEFINITIONS

Not used.

02204.2 MATERIALS

Water shall be free of dirt and silt or any substances injurious to plant life. A separate supply of potable water shall be provided for drinking when it becomes necessary to provide water for workers.

02204.3 CONSTRUCTION REQUIREMENTS

Water provided for construction shall be obtained from a source approved by the Engineer and sufficient to provide for the anticipated needs of the contract.

Water hauling equipment shall have watertight tanks of known capacity and shall be equipped with a pressure pump and spray system with the capability of applying the whole load uniformly. The spray system shall have a positive shut-off control. The water tank shall have a minimum capacity of 1,000 U.S. Gallons, and the capacity shall be clearly marked on the tank. The Contractor may be required to verify the tank capacity.

A water meter may be used for water dispensing, providing its measurement can be verified.

02204.4 METHOD OF MEASUREMENT

Unless indicated otherwise in the Bid Schedule, no separate measurement will be made for water used for pre-wetting, mixing, or compaction of earth materials or for dust control.

When shown in the Bid Schedule, water shall be measured to the nearest 1/10th of 1000 gallons in calibrated tanks or tanks with approved metering devices that indicate volume in 100-gallon quantities.

02204.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

PAYMENT ITEM	UNIT
Water	M Gallons (1,000 US Gallons)

02206.1 DESCRIPTION

This section covers activities associated with two types of temporary road use. These are construction and use of access roads and use of existing roads which are part of the construction zone.

02206.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 01300 - Submittals
Section 02005 – Traffic Control
Section 02015 - Clearing and Grubbing
Section 02105 - Earthwork Materials
Section 02202 – Roadway Excavation and Embankment

02206.1.2 SUBMITTALS

When gravel surfacing is required, the Contractor shall submit samples and/or test data for those materials in accordance with Sections 02105 and 01300.

02206.1.3 DEFINITIONS

Access Roads – A project site access road built specifically for temporary use by project related vehicles during the construction phase of the Work. The road may be on or partially on the construction zone or only end at it.

Temporary Use of Roads – Use of an existing paved or unpaved roadway during the construction phase of a project involving degradation of the surface and/or the use of the road by the public. Temporary road use may constitute use of the roadway as all or part of the construction zone or as an immediate approach to the construction zone.

02206.2 MATERIALS**02206.2.1 ACCESS ROADS**

When shown on the Drawings, surfacing material for access roads shall be Untreated Base Course (UBC) gravel which meets the requirements of Section 02105.

02206.2.2 TEMPORARY USE OF ROADS

Materials requirements for restoring and resurfacing existing roads that have been damaged or disturbed during construction will be as shown on the Plans and described elsewhere within these Specifications.

02206.3 CONSTRUCTION REQUIREMENTS**02206.3.1 ACCESS ROADS**

Consists of excavating, filling, installing gravel surfacing, and other work necessary to construct minor access roads for which cut and fill quantities will not be determined.

02206.3.1.1 CLEARING - The area to be disturbed by the road construction operation shall be cleared of all trees, brush, rubbish and other objectionable matter in accordance with Section 02015 prior to beginning the trenching operation. Trees, brush, rubbish and other materials resulting from the clearing operation shall be removed and disposed of at a land fill approved by the local public

authority or designated by the Engineer. Removal of these materials shall be considered as part of the Work for access road construction and no separate measurement and payment will be made for their removal.

02206.3.1.2 **UNSUITABLE MATERIAL** - Material shall be considered unsuitable for fill, sub-grade, shoulders and other uses if it contains organic matter, soft spongy earth or other matter of such nature that compaction to the specified density is unobtainable.

Material that is unsuitable for the intended use shall be excavated and removed from the site to an approved disposal site or otherwise disposed of as directed by the Engineer.

02206.3.1.3 **SLOPES** – Slopes shall be as follows:

- Excavation slopes shall be finished in conformance with the lines and grades shown on the Drawings. Debris and loose material shall be removed.
- Tops of slopes shall be rounded as shown on the Drawings. Excavation and embankment lines shall conform to those shown on the Drawings. When completed, the road grade shall be uniform and shall provide a smooth driving surface for vehicles.

02206.3.1.4 **MATERIAL AVAILABILITY** - The Contractor shall utilize all suitable excavated material within the roadway. When it is determined that sufficient excavated material is not available to construct required embankment, the Engineer may designate borrow sites and, if deemed to be changed conditions, appropriate changes will be negotiated in accordance with the General Conditions.

02206.3.1.5 **COMPACTION** - Materials in embankments shall be placed in layers not more than 12-inches in thickness and then wheel rolled with the equipment used for placement.

Placement of surfacing shall be made in accordance with the details shown on the Drawings and then compacted by wheel rolling with equipment used for placement.

02206.3.1.6 **TRAFFIC CONTROL** - At all points where access roads come into contact with public thoroughfares, the Contractor shall establish and maintain adequate traffic control as described in Section 02005 and as required by the specifications of the state or local highway or road department having authority at the site.

02206.3.1.7 **ENVIRONMENTAL CONTROL** – During construction and use of access roads, the Contractor shall observe the requirements of Section 01520 with particular regard to dust abatement.

02206.3.2 **TEMPORARY USE OF ROADS**

02206.3.2.1 **TRAFFIC CONTROL** - At all times when the Contractor is making temporary use of public thoroughfares, the Contractor shall establish and maintain adequate traffic control as described in Section 02005 and as required by the specifications of the state or local highway or road department having authority at the site.

02206.3.2.2 **PASSIBILITY** – When a portion of a public thoroughfare is being utilized for construction purposes, the Contractor shall maintain as many open lanes as possible for the passage of traffic consistent with safety and good construction practice. Lanes open to traffic shall be managed and maintained free of any debris or material that might passibility and public safety.

When traffic must be limited to the use of only one lane, traffic flow shall be managed so that no undue or unreasonable delays occur. If travel on all lanes of the roadway must be interrupted for

an extended period of time, the Contractor shall first prepare an adequate detour plan and have it approved by the local road or highway department.

02206.3.2.3 ENVIRONMENTAL CONTROL – While using existing roads for construction purposes, the Contractor shall observe and be responsible for the requirements of Section 01520 with particular regard to dust abatement. When sprinkling with water is being used to control dust, the Contractor shall make as many passes as are necessary, and as may be directed by the engineer, to keep the creation of dust at a minimum. While sprinkling, the Contractor shall take particular care to avoid creating slippery or otherwise hazardous conditions on any part of the roadway being used for vehicular traffic.

02206.4 METHOD OF MEASUREMENT

02206.4.1 CONSTRUCTION OF ROADS

Measurement for construction of access roads shall be made by the number of lineal feet of road excavated, compacted and graded to provide either a driveable surface or a base ready for installing gravel surfacing.

02206.4.2 GRAVEL SURFACING

Separate measurement for gravel surfacing shall be made in accordance with Section 02105 for Untreated Base Course.

02206.4.3 TEMPORARY USE OF ROADS

Restoration and resurfacing of roads disturbed or damaged during temporary use for construction shall be included with other items on the Bid Schedule and no measurement or payment for this work shall be made under this specification.

02206.5 BASIS OF PAYMENT

The accepted quantity will be paid for at the contract unit price for:

PAY ITEM	UNIT
Access Road	Lineal Foot

02208.1 DESCRIPTION

Furnish and place flowable fill for backfill in roadway trenches.

02208.1.1 MATERIALS

Cement – Use Portland Cement, Type I or II

Fly Ash – Loss on ignition must be 3% or less.

Fine Aggregate

Natural Sand

Meet the following gradation when test is specified.

Table 02208.1.1	
Sieve Size	Percent Passing
No. 3/4	100
No. 100	0-10

02208.1.2 MIX DESIGN

Meet the following requirements.

Mix design compressive strength (28-day) – between 50 to 150 psi.

Portland Cement – at least 50 pounds/cubic yard

Fly Ash – at least 300 pounds/cubic yard

Slump – 6-10 inches maximum

02208.1.3 FINISH

Finish to a flat surface.

02208.2 METHOD OF MEASUREMENT

02208.2.1 The amount of flowable backfill shall be determined by measuring the lineal feet of trench requiring flowable backfill and accepted as called out in the Contract Documents. No measurement will be given to flowable backfill used in locations not required in the Drawings. Unless called out elsewhere, the measurement will begin and end two feet each side of the existing asphalt surface.

02208.3 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
Flowable Backfill	Lineal Foot

02222.1 DESCRIPTION

This section covers furnishing and installation of pipe and fittings of the type, class and size designated for the water system defined on the Drawings, in these Specifications, and elsewhere in the Contract Documents.

02222.1.1 RELATED WORK

Section 02105 - Earthwork Materials
Section 02200 - Trench Excavation and Backfill
Section 15110 - Pipe and Piping Systems
Section 15230 - Waterline Valves and Hydrants
Section 15232 - Water System Control Valves
Section 15234 - Water Service Connections
Section 15236 - Water Main Flow Meters

02222.1.2 SUBMITTALS

02222.1.2.1 MATERIALS AND EQUIPMENT - The Contractor shall submit for review complete information, showing all pipe, materials, fittings, gaskets, couplings, coatings, linings, supports, mechanical restraints, thrust blocks and configuration prior to the delivery of any components to the project. All information shall be provided in accordance with Section 01300 and written evidence of compliance from the manufacturer shall be provided with each delivery of material.

02222.1.2.2 TESTING - As construction proceeds, the Contractor shall submit test documentation in accordance with this section of these Specifications.

02222.1.3 DEFINITIONS

Fitting - Any component of a pipeline, excluding the pipe itself and valves and meters, which is used for connecting pipe sections; changing line direction or size; connecting meters, valves, tanks, etc.; or starting or terminating pipelines.

Mains - Water distribution pipes, located in streets or rights-of-ways, to which water service connections are made for users of the system.

Run - Any identified section of a pipeline.

Saddle - A fitting placed on a pipe to reinforce the pipe wall, through which a tapping hole is drilled.

Service Lateral - The line which connects to the water meter or to the service stub at the property line extending from there, on private property, to the plumbing at the foundation of a house or business.

Service Stub - The line running from the tap on a main to the meter or to the property line as appropriate.

Tap - The actual connection made to water mains which includes drilling an opening into the main, threading, installing a tapping saddle when appropriate, and installing a valve into the opening.

02222.2 MATERIALS

02222.2.1 PIPE AND FITTINGS

See Section 15110

02222.2.2 PIPELINE LOCATION IDENTIFIERS

Pipeline location identifiers generally take the form of marker posts, warning tape, and tracer wire.

02222.2.2.1 TRACER WIRE - Unless otherwise described on the plans or herein, the tracer wire shall be an insulated, #12, direct bury copper wire designed and manufactured for this purpose.

02222.2.2.2 WARNING TAPE - The warning tape shall be an inert, plastic, direct bury type with a 2-inch minimum width, of the appropriate safety color, and specifically manufactured for underground utility identification. The tape shall have wording imprinted on it identifying the type of utility it is protecting.

02222.2.2.3 MARKING POSTS - Shall be fiberglass compound, aluminum, or other corrosion resistant metal of 5-foot length and 4 inches wide, or otherwise as shown on the Drawings. They shall be fitted with a deterioration resistant warning notice or label appropriate to the application.

02222.2.3 MISCELLANEOUS FITTINGS AND MATERIALS

02222.2.3.1 POLYETHYLENE ENCASUREMENT - Where soil conditions are determined to be severely corrosive and when shown on the Drawings or required in the Contract Documents, tubular polyethylene encasement shall be installed around buried ductile iron piping and fittings in accordance with ANSI/AWWA C-105.

02222.2.3.2 CASING PIPE - Where casing pipe is called for on the Drawings or is required by the Engineer, the Contractor shall furnish and install the casing in accordance with Sections 02315 and 02320 of these specifications.

02222.2.3.3 PIPE PENETRATION OR CASING SEALS - Where required on the Drawings or in these Specifications, the Contractor shall furnish and install pipe-to-wall linked rubber seals in core drilled structures, walls, pipe sleeves, or casings in accordance with the manufacturer's instructions. Seals shall be link seals by Thunderline Corporation, or an approved equal.

02222.2.3.4 PIPE RESTRAINTS – Pipe restraints shall be as follows:

- Concrete thrust blocking shall be formed, sized, and placed as described herein and shown on the Drawings. Reinforcing bars used in thrust block construction shall be preformed and fusion bonded epoxy coated.
- Mechanical restraint of piping shall be accomplished with one of the following restraining systems or an approved equal:
 - ⇒ Grooved Ductile Iron AWWA Couplings by Victaulic Company of America (use only with exposed piping systems).
 - ⇒ MEGALUG thrust restraints by EBAA Iron Sales, Inc.

⇒ FIELDLOK restraint gaskets by U.S. Pipe Company. Without the written approval of the Engineer, use of this restraint device is limited to joints in carrier pipe installed in a casing pipe.

All joints of pipe installed under streambeds or canal crossings, or installed in casing pipes, shall be protected with mechanical restraint.

Restraint protection of above ground or exposed piping in buildings or enclosures shall be accomplished only with mechanical restraints.

02222.3 CONSTRUCTION REQUIREMENTS

02222.3.1 HANDLING AND APPROVAL OR REJECTION OF MATERIALS

All materials delivered to and used at the job site are subject to approval of the Engineer or the Owner. Care shall be taken during handling of pipe, to avoid any impact which might cause damage. Dropping pipe during unloading will not be permitted. Pipe will be carefully inspected in the field before and after laying. If any cause for rejection is discovered in a pipe before or after laying, it shall be removed and replaced by the Contractor, at no additional cost to the Owner. Any pipe found to be unfit or rejected due to cracks, broken bells or spigots, irreparable chipped lining, etc., shall be removed from the job site.

02222.3.2 DIAGRAMMATIC LAYOUT

Piping layout on the Drawings shall be considered diagrammatic for all piping not shown with detailed dimensions. When this is the case, pipe size and location are provided, but the Drawings are not intended to show every offset, fitting, or structural difficulty that will be encountered during project construction.

02222.3.3 ALTERATION OF ALIGNMENT

At no additional cost to the Owner, and with written permission from the Engineer, piping alignment may be varied from that shown on the Drawings, to avoid structural or mechanical difficulties, or to avoid the work of other trades. The Contractor still will be liable to provide all materials and labor required to complete all work in accordance with the best practice of the trade, and to the satisfaction of the Engineer.

02222.3.4 INSTALLATION

02222.3.4.1 DEWATERING - Prior to pipe laying and jointing, sufficient dewatering effort shall be provided to maintain the ground water level at or below the surface of the trench bottom or base of the bedding course. The dewatering operation; however accomplished, shall be carried out in such a manner as to not permanently disturb natural underground water conditions.

02222.3.4.2 CONNECTION TO EXISTING FACILITIES - When connections are to be made to any existing pipe or appurtenances, for which the actual elevation or position cannot be determined without excavation, the Contractor shall excavate for, and expose the existing pipe or appurtenances before laying any new pipe. The Engineer shall be allowed to inspect the existing pipe or appurtenances before any connection is made. The Contractor shall make any adjustments in line or grade which may be necessary to accomplish the intent shown on the Drawings.

Where new fittings, valves, meters, restraints etc., are required to be installed in, or attached to, existing piping, or where connections are to be made to existing piping, the Contractor shall

furnish and install the necessary components needed to accomplish the work, whether or not specifically indicated on the Drawings.

02222.3.4.3 CAPPING PIPE END - At the close of each workday, or whenever the work ceases for any reason, the end of the pipe shall be securely closed, unless otherwise permitted by the Engineer.

02222.3.4.4 JOINING – Joining of pipe shall be as follows:

- When making connections, pipe shall be cut and beveled in a neat and workmanlike manner, so as to provide a smooth, beveled end at right angles to the axis of the pipe. Pipe and fittings shall be assembled so there will be no distortion or springing of the pipelines. Flanges, unions, flexible couplings and other connections shall come together at the proper orientation. The fit shall not be made by springing any piping, nor shall orientation or alignment be corrected by taking up on any flange bolts. Flange bolts, union halves, flexible connectors, etc., shall slip freely into place. If the proper fit is not obtained, the piping shall be altered to fit.
- PVC pipe, 2 inches and smaller in diameter, shall be joined by solvent welding. No disturbance of joints, including from trench backfill operations, will be allowed until solvent welded joints are cured.
- PVC pipe, larger than 2 inches in diameter, shall be joined by means of gasketed joints.
- With bell and spigot joints, care should be taken to properly align the pipe before joints are forced home. Gaskets shall be lubricated in accordance with manufacturer's instructions. During insertion of the spigot end, the pipe shall be partially supported by hand, sling, or crane to minimize unequal lateral pressure on the gasket and to maintain concentricity until the gasket is properly positioned. Since the most flexible gasketed joints tend to creep apart when the end pipe is deflected and straightened, such movement shall be held to a minimum once the joint is home.
- Where fusion of polyethylene pipe joints is required, sections of pipe shall be joined in a continuous length on the job site above ground. Joining shall be by the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. Equipment used for butt fusion joining shall be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements, alignment, and fusion pressures.

02222.3.4.5 LAYING - All pipe laid shall be retained in position, using mechanical means if necessary, so as to maintain alignment and joint closure until sufficient pipe bedding and backfill have been completed to adequately hold the pipe in place. All pipe shall be laid to conform to the prescribed line and grade shown on the plans, within specified limits. No blocking of any kind shall be used to adjust the pipe to grade, except when used with concrete embedment. Bedding materials shall be placed so the bottom surface of the pipe will have full bearing for the entire barrel length. The pipe shall rest on not less than 1/4 of its outside perimeter. Bell holes shall be dug as required to assure uniform support along the barrel but shall be no larger than necessary.

Unless otherwise approved by the Engineer, pipe shall be laid upgrade from the point of connection on the existing pipeline or from a designated starting point. Pipe shall be installed with the bell end forward or upgrade, unless approved otherwise. When pipe laying is not in progress, the forward end of the pipe shall be kept closed with an approved temporary plug.

02222.3.4.6 PIPE RESTRAINT – Pipe restraint work shall be as follows:

- The Contractor shall provide and install either concrete thrust blocks or mechanical pipe restraints on all pressure piping not connected with bolted flanges or welded joints.
- For projects involving pipeline construction covered under this section of the Specifications, a pipe restraint schedule is included in the Drawings. Pipe restraints (thrust blocks and/or mechanical restraints) shall be furnished and/or constructed and installed as shown on the Drawings and described in the schedule.
- Pressure pipe shall be properly blocked or restrained at all fittings, wherever the pipeline makes a change in direction of 11.25 degrees or more, wherever it changes sizes, or wherever it ends.
- Placement of concrete thrust blocking shall provide bearing against undisturbed vertical earth banks or approved compacted backfill, sufficient to absorb thrust from line pressure, and in a configuration so that pipe joints and fittings will be accessible.
- All restraints shall be in place before any hydrostatic testing and flushing are performed on the system.
- The Contractor shall allow visual inspection of every thrust block or mechanical restraint before it is buried.

02222.3.4.7 FINISH BEDDING - After the pipe is laid, additional bedding material shall be placed in 6-inch lifts to a level even with the spring line of the pipe and compacted. The portion of the trench from the spring line to 12 inches above the top of the pipe shall then be filled and compacted in the same way.

02222.3.4.8 REQUIREMENTS FOR INSTALLATION NEAR SEWER LINES - Locate potable water piping at least 10 feet horizontally (measured edge to edge) from any existing or proposed parallel sewer or wastewater leach line. Should conditions prevent the 10-foot separation, upon the Engineers approval the water line may be laid closer than 10 feet to sewer lines (but not leach lines) provided:

- The water line is laid 18 inches above the top of the sewer line, but deep enough to prevent freezing, and
- There is no groundwater impacting the trench, and
- No sewer force main exists, and
- The water line is laid in a separate trench, or
- The water line is laid on an undisturbed earth shelf on one side of the sewer line trench, or

Where potable water lines cross sewer lines, the bottom of the water line shall be at least 18 inches above the top of the sewer line for ten feet on each side of the sewer line, measuring perpendicularly from the water line to the sewer line. When such vertical separation is impossible to achieve, a vertical separation of less than 18 inches may be allowed provided:

- In new construction for both water line and sewer line they shall be constructed of ductile iron pipe or thermoplastic pipe joined by either mechanical or bolted flange joints.

- In situations with an existing sewer line, the new water line shall be constructed as previously described.
- And, when making such crossing, install the water line in such manner that the center of a full length of pipe is on the centerline of the sewer line to isolate the water line joints as far as possible from the sewer line.

02222.3.4.9 **EXPOSED PIPING** - No exposed piping shall be installed until all equipment to which the pipe is to be attached has been installed and it can be determined where piping and fittings shall be located to make a neat, efficient arrangement. Piping shall be aligned with equipment connections such that no external load or stress will be transferred to any equipment from the piping. Piping shall be installed with a sufficient number of unions, flexible couplings, or flanged joints, in addition to those shown on the Drawings, to allow for convenient inspection and maintenance.

Exposed pipe work shall be suspended or supported, to prevent sagging or over-stressing of the pipe and connections. Assembly of pipe and fittings shall be accomplished so there will be no distortion or springing of the pipe. The fit shall not be made nor the alignment corrected by taking up on any flange bolts. Joints shall come together in proper orientation, and Flange bolts, union halves, flexible couplings, and etc. shall slip freely into place. If the proper fit is not obtained, the piping shall be altered to make the fit meeting the above requirements.

Exposed pipe shall be installed in straight runs parallel to the axis of the structures. Pipe runs shall be horizontal and vertical; except that gravity drain lines shall be pitched down in the direction of flow at a slope not less than 1/8 inch per foot.

All exposed pipe shall be painted in accordance with Section 09910 of these Specifications. Factory finished items are not required to be field painted except touch-up. The color and type of paint used shall be submitted to the Engineer for his approval.

02222.3.4.10 **DRAINS AND OTHER SYSTEMS** - In addition to other requirements in this Section, all irrigation and other lines fitted with drains shall be installed such that continuous slope is maintained to designated drain locations. In areas where there are both culinary water pipelines and irrigation pipelines, exposed portions of irrigation water piping shall be identified by distinctive coloring or other marking. Culinary and irrigation lines and extensions shall be completely separated, installed in separate trenches, and there shall be no cross-connection between the systems under any circumstances.

02222.3.5 **SPECIAL CONSIDERATIONS FOR HDPE PIPE**

02222.3.5.1 **HANDLING AND STORAGE** – Polyethylene pipe is able to withstand normal installation handling. However, unusually rough handling of polyethylene pipe can result in damage to the pipe wall. Care shall be taken to avoid pushing or pulling polyethylene pipe over or around sharp projections. Polyethylene pipe is subject to impact damage when dropped from excessive heights or when heavy objects are dropped upon it, particularly during cold weather. Kinking or buckling shall be avoided and any section of pipe which has been damaged in this manner shall be cut out and replaced. If a scratch depth is greater than 10% of the pipe wall thickness, then the section shall be removed and replaced.

02222.3.5.2 **FUSION JOINT INSPECTION** – The field technique for evaluating a butt fusion joint is bead appearance. The recommended procedures should result in the desired appearance. The Contractor shall inspect the entire circumference of the fused joint for uniform non-porous bead alignment. Improper fusion shall be redone. The Contractor shall comply with the Butt Fusion Joint Appearance Guide recommended by the manufacturer.

02222.3.5.3 **PIPE PLACEMENT** – Polyethylene pipe can be joined either above ground or in the ditch as the situation dictates. Though most joining can be accomplished above ground, joining which must be done in the ditch shall be well planned to ensure that enough space is available and that proper alignment is achieved. Care shall be taken to avoid buckling, gouging, and other mechanical damage when lowering polyethylene pipe into the ditch. The pipe should be laid so that there are no bends with a radius less than 20 times the pipe diameter and no joints within 3 feet of any bends. (90 times the pipe diameter at fusions.)

- Align all pipe and fitting joints true to line and grade. Extremely cold weather makes polyethylene pipe stiffer and increases the likelihood of impact damage.
- Because plastic pipe contracts as it cools, it is desirable in hot weather to snake the pipe in the bottom of the trench. This provides for “slack” in the pipeline to be taken up as the pipe cools and contracts in the ditch prior to backfilling. It is recommended that backfilling be accomplished after the pipe has cooled in the shade of the trench.

02222.3.5.4 **HYDROSTATIC LEAK TESTING** – Hydrostatic testing of the HDPE pipeline shall be performed on as complete of sections of the installed pipeline as possible and in the presence of the Engineer. Hydrostatic testing procedures shall be as described by “DriscoPlex” Bulletin: PP 802-TN, Test Phase Alternate #1 (www.driscoplex.com). Under no conditions except with the written consent of the Engineer shall pneumatic testing be allowed. Pressure recordings and other testing data shall be kept by the Contractor and supplied to the Engineer upon successful completion of the testing procedures.

02222.3.6 **FLUSHING AND CLEANING**

02222.3.6.1 **FLUSHING WITH WATER** - Prior to proceeding with pressure testing (and/or disinfection if required) of completed lines, the Contractor shall fill the test section with clean, potable water and flush the lines. The Contractor shall furnish all equipment and labor to complete the flushing as required by this section. Water for flushing shall be provided by the Owner.

02222.3.6.2 **DIFFICULT CONTAMINANTS** - Certain contaminants, especially in caked deposits, resist flushing at any velocity. If, in the opinion of the Engineer, such contaminants have entered the line during construction, the interior of the pipe shall be swabbed, as necessary, to remove the debris prior to proceeding with flushing.

02222.3.6.3 **MINIMUM FLUSHING FLOW AND VELOCITY** - The Contractor shall make all arrangements, to establish a minimum 2.5 feet per second (fps) flow velocity in the line during the flush. Flushing shall proceed until the installed pipe is free of debris. The flows needed to produce the required flushing velocity indicated above are provided in the table below.

FLUSHING FLOW AND VELOCITY

Pipe Diameter (inches)	Flow (gpm) to Produce 2.5 fps
4	100
6	200
8	400
10	600
12	900
16	1600

NOTE: With 40 psi residual pressure, 2 1/2 inch and 4-1/2 inch hydrant outlet nozzles will have the ability to discharge approximately 1,000 GPM and 2,500 GPM respectively.

02222.3.7 TESTING

The Contractor shall perform all testing, and shall furnish all materials, equipment, and labor necessary to complete this work as required. Any work that fails to meet the acceptance criteria of prescribed testing shall be repaired and/or replaced at no additional cost to the owner. All repaired work shall be re-tested. This sequence shall be repeated until the work meets the acceptance criteria.

02222.3.7.1 PRESSURE TESTING - All pipelines constructed for carrying potable, non-potable, and water-borne products shall be pressure tested for leakage when they are completely assembled, unless directed otherwise in these Specifications or in writing by the Engineer.

WARNING - The hydrostatic test procedures described herein are not applicable to air pressure testing.

Prior to pressurization all required flushing shall have been completed. Pipeline sections to be tested shall be isolated from any connecting lines. Air release taps shall be provided at points of highest elevation, the test section shall be filled with clean potable water, and all air shall be removed from the line. Pressure on the test section shall then be brought to full test pressure and maintained at that level for a period of not less than 4 hours. Pipelines shall be tested at 50 psi over normal static pressures shown on the Drawings or to the manufacturer's class rating, whichever ever is lower. Permanent plugs shall be inserted into the air release tap holes after the test has been completed.

02222.3.7.2 LEAKAGE TESTING - The leakage test shall be conducted concurrent with the pressure test. Amount of leakage, if any, will be determined by measuring the quantity of additional water required to maintain the prescribed hydrostatic pressure test during the test period. Accurate means shall be provided to measure the quantity of water required to maintain full pressure on the line for the 4-hour test period, the measured leak rate shall not exceed the rate "L" computed as follows:

$$L = SD(P^{0.5})/133,200$$

where: L = Leakage rate (gal/hour)
 S = Length of tested pipe (feet)
 D = Nominal diameter of pipe (inches)
 P = Average test pressure (psi)

When the allowed amount of leakage is exceeded, leaks shall be located and repaired and the system shall then be re-tested by the Contractor until compliance is achieved.

All visible leaks in exposed pipe shall be repaired.

02222.3.7.3 OPERATIONAL TESTING (*pressurized irrigation only*) - Pressurized irrigation systems shall be tested for proper system operation after backfill is in place and sprinkler heads have been adjusted to final position. This test shall demonstrate that the system meets coverage requirements (based on operation of one circuit at a time) and that all automatic controls function properly.

02222.3.7.4 NON-RIGID PIPE DEFLECTION TESTING - At the Engineer's request, the Contractor shall test requested portions of all non-rigid pipe after being installed and backfilled to ensure that circumferential deflection does not exceed 5% of the diameter. Such test will consist of passing a mandrel through an open section of pipe, sized appropriately to detect non-compliance. The mandrel shall be sized in accordance with the requirements provided in Section 02224 for checking sewer pipe. In the event deflection non-compliance is found, the Contractor shall make

repairs as outlined in Section 02224 and additional testing of other sections of pipe will be requested.

02222.3.7.5 TESTING DOCUMENTATION - The Contractor shall maintain a record of all testing performed, together with the test results obtained, for each line installed under this Contract. Minimum information to be included in these records shall be as follows:

- All Documents:
 - Date of issuance of the record
 - Name of Contract
 - Contractor's name and address

- Disinfection Report:
 - Name and address of treatment supervisor
 - Disinfection method used
 - Location and boundary description of section to be disinfected
 - Time and date of disinfectant introduction
 - Time and date of disinfectant release
 - Initial disinfectant residual (PPM) for each outlet tested
 - Time and date of flushing after disinfection
 - Signature of treatment supervisor (signifies completion of disinfection activities)

- Bacteriological Report:
 - Date issued
 - Project name and location
 - Laboratory's name, certification number, address and phone number
 - Test location
 - Time and date of sample collection
 - Name of person collecting sample
 - Time and date of laboratory test start
 - Coliform bacteria test results for each sample
 - Certification that water conforms (or fails to conform) to bacterial standards of the appropriate state public drinking water regulations
 - Bacteriologist's signature

- Test Report:
 - Type of test
 - Location of test
 - Sizes, types, and lengths of pipe in test section, and test boundary description
 - Date and Time test started
 - Date and Time test completed
 - Test pressure (*Pressure Test only*)
 - Amount of leakage/allowable leakage (*Pressure Test only*)
 - Mandrel dimensions (*Obstruction and Non-Rigid Pipe Deflection Tests only*)
 - Test result (*pass/fail*) (*All Tests*)
 - Printed Name/Signature and Date of Test Supervisor (Contractor's representative) (*All Tests*)
 - Printed Name/Signature of Inspector (Engineer's representative) witnessing and approving the test (*All Tests*)

02222.3.8 DISINFECTION

02222.3.8.1 REGULATORY COMPLIANCE - All pipelines to be used for culinary water service shall be disinfected in accordance with the requirements of state and local public drinking water regulations.

02222.3.8.2 METHODS - The Contractor may use any method which complies with the above referenced standards; however, the “slug method”, prescribed in ANSI/AWWA C-651, is preferred. This method basically consists of filling the line with potable water and then injecting a “slug” of concentrated chlorine solution (100 mg/L) at the upstream end of the line. The “slug” is then moved through the line by slowly draining the low end. When properly conducted, this procedure provides contact to the interior pipe surfaces with a heavily concentrated dose of chlorine to achieve disinfection.

02222.3.8.3 FLUSHING - After disinfection, the lines shall be flushed until residual chlorine is reduced to the levels safe for consumption. Samples for bacteriological testing can then be taken. The Contractor shall safely and legally dispose of contaminated water used for disinfection after consultation with the local authorities. Under no circumstances shall heavily chlorinated water be allowed to mix with “live” waters, meaning waters in lakes, rivers, streams or wetlands.

02222.3.9 PIPELINE LOCATION IDENTIFIERS

The Contractor shall furnish and install such identifiers as shown on the Drawings and/or prescribed in these Specifications.

02222.3.9.1 TRACER WIRE – Tracer wire shall always be installed in the trench with non-metallic pipelines, during or immediately following their installation and may be required in the installation of metallic pipelines where electric conductance is necessary and is not provided through the pipeline because of its type of construction. Tracer wire placement shall be as shown on the Plans but shall generally be immediately beneath (preferred), to the side, or above the pipeline with approximately 4 inches of separation. Tracer wire shall be brought to the surface of the ground at all valves and risers and where otherwise shown on the plans.

Tracer wire shall be installed as shown in the Plan details. Where splices in the wire are required, the Contractor shall use the manufacturer recommended splice nut (cap) to provide a watertight joint. Extend electrical tape well over the wire insulation in all directions.

The Contractor shall provide all necessary labor, equipment, and materials to perform an electrical continuity test prior to acceptance on all installed tracer wire. The test shall be performed in the presence of the Engineer or an appointed representative. The continuity test shall be conducted using an ohmmeter. Continuity must be demonstrated to pass the test. In the event of a failed test, the Contractor shall make all necessary repairs required to provide a tracer wire system that complies with the testing requirements of this section.

Some soil conditions and/or installation circumstances may require the additional installation of cathodic protection for the tracer wire. When this is the case, cathodic protection will appear as a separate bid item and details for its installation will appear on the Plans and elsewhere in these Specifications.

02222.3.9.2 WARNING TAPE – A continuous ribbon of warning tape shall be installed during the backfill operation. Tape shall be placed a minimum of 12-inches above the top of the pipeline or at a depth approved by the Engineer, or otherwise as shown on the drawings. At roll ends and at places where the tape has been broken, the loose ends shall be tied together to prevent separation during the rest of backfill.

02222.3.9.3 **MARKING POSTS** – Marking posts shall be installed at the placement intervals shown on the Plans. Posts shall not be deformed or damaged during installation. The Contractor shall use a post hole digger to install markers when there is danger of damage to posts from pounding or hammering

02222.3.10 **CLEANUP**

Following acceptance of testing and completion of backfilling and surface restoration, the Contractor shall prepare the work for contract closeout in accordance with Section 01200 of these Specifications.

02222.4 METHOD OF MEASUREMENT

02222.4.1 **BURIED WATER LINES**

The amount of buried water line pipe shall be determined by measuring the lineal feet of pipe in place and accepted, including the lengths of fittings, valves, couplings, and portions of pipe within casings, unless called out otherwise in the Contract Documents.

Measurement of lines passing through, or connecting to control valves or other operating devices enclosed in vaults or manholes, shall be made only up to the pay limit of the enclosure or vault as shown on the Drawings. If no pay limit is shown, measurement will be made to a point five (5) feet outside of the enclosure.

Measurement of ductile iron pipe shall include polyethylene encasement where that material is required.

02222.4.2 **PIPELINE LOCATION IDENTIFIERS**

Measurement of tracer wire and location markers installed with non-metallic pipe shall be included in the measurement of the waterline pipe unless they are separate bid items in which case measurement for tracer wire shall be the same as the length of waterline installed and location markers shall be measured by counting the number of markers installed.

02222.4.3 **EXPOSED PIPELINES**

Exposed water pipe shall not be measured in connection with the installation of water lines but shall be included in the measurement of the structure or facility where the exposed pipe is located, and payment for such pipe shall be included in the payment for those bid items.

02222.4.4 **FITTINGS**

Unless specifically called out for separate payment on the Bid Schedule, fittings for pipelines and piping systems will be considered appurtenant to the line or system being installed, and measurement for such fittings will be included in the measurement for that pipeline or piping system.

02222.4.5 **MISCELLANEOUS**

Separate measurement for valves and vaults and enclosures and their contents will be as described in other sections of these Specifications.

02222.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
<i>(size)</i> PVC Pipe (<i>Class</i>) [AWWA C-900] or [<i>Pressure rated</i>]	Lineal Foot
<i>(size)</i> DI Pipe (<i>Class</i>)	Lineal Foot
<i>(size)</i> HDPE Pipe [IPS] or [DIPS] C906 SDR (#)	Lineal Foot
<i>(size)</i> Galvanized Iron Pipe (<i>Schedule</i>)	Lineal Foot
Pipeline Location Markers	Each

No separate payment will be made for fittings unless called for on the Bid Schedule.

02224.1 DESCRIPTION

Includes furnishing and installation of pipe, fittings and manholes and their appurtenances for sanitary and storm sewers and subsurface drainage systems.

02224.1.1 RELATED WORK

Section 02105 - Earthwork Materials
Section 02200 - Trench Excavation and Backfill
Section 03500 - Pre-Cast Concrete Components
Section 15110 - Pipe and Piping Systems

02224.1.2 DEFINITIONS

Culvert - A section of pipe installed transversely under a road, highway, railroad, or canal for the purpose of conveying water flow.

Fitting - Any component of a pipeline, excluding the pipe itself, which is used for connecting pipe sections or connecting to valves, tanks, structures, etc.

Flowline - A line formed by the inverts of a pipeline.

Infiltration - Any uncontrolled seepage of groundwater into a sewer line or system.

Inflow - Any water entering a sewer.

Invert - The bottom or lowest point of the internal surface of a cross-section of a pipeline.

Lateral - Any line which connects to, and extends from, a sewer main line. A Service Lateral is any line which connects to a sewer service stub at the property line and extends on private property to the sewer plumbing at the foundation of a house or business.

Permeability - The property of a material which describes the rate of movement of any fluid through the pores of the material.

Resilient Connector - A flexible (rubber, plastic, etc.) connection fitting manufactured specifically for joining one pipe to another or to a structure, and capable of being deflected or deformed without leakage.

Run - Any identified section of a pipeline.

Service Stub - The line which connects to a sewer main line at the service tap and extends from there to the property line.

Service Taps - Connections to sewer main collection lines from individual services.

Springline - The points of maximum horizontal distance on the inside surface of a circular pipe or in rectangular pipe; the mid height of the internal vertical walls.

02224.1.3 SUBMITTALS

The Contractor shall submit for review, complete information for pipe, fittings, gaskets, manholes, prefabricated boxes and entry covers which clearly describes those materials and their finishes and interior coatings. This information shall be furnished to the Engineer before delivery orders for materials are placed with the respective suppliers.

All information shall be provided in accordance with Section 01300 and written evidence of compliance shall be provided with each delivery of material.

02224.2 MATERIALS**02224.2.1 PIPE**

See Section 15110 for pipe materials specifications.

02224.2.2 MANHOLES AND ENCLOSURES

02224.2.2.1 MANHOLES - Manholes consist of the base, riser, cone, grade rings, rings and covers. Manholes shall be constructed of pre-cast, reinforced concrete and shall conform to the Drawings, to Section 03500 of these Specifications, and to ASTM Standard C478. Unless shown otherwise on the Drawings, the wall thickness of 48-inch and 60 inch manholes shall be minimum 5-inches and 6-inches respectively. Cone sections shall be eccentric and be designed to meet AASHTO HS-20 loading requirements. Pipe connections and/or knockouts shall be sized and located according to the Drawings. Grade rings shall have 4-inches minimum vertical thickness. No more than two grade rings per manhole shall be used.

02224.2.2.2 JOINTS - All manhole components shall be joined with tongue and groove joints and joints shall be sealed so that they are watertight. Sealant materials shall be flexible butyl resin sealant which conforms to AASHTO M-198B, or a rubber gasket may be used if it is specifically designed for installation in concrete manholes and conforms to ASTM C-361.

02224.2.2.3 RINGS AND COVERS - Manhole rings and covers shall be cast iron, be H-20 loading rated, be manufactured to fit the concrete openings of the manhole and shall meet the requirements of ASTM A48, Class 30B. The clear opening of the ring shall be 24-inches minimum. Vented covers, without dustpans, shall be provided for all manholes located where drainage or flooding will not occur. Watertight covers shall be provided wherever the manhole may be flooded with street runoff or floodwater. Combined weight of the ring and cover shall be not less than 360-pounds. All covers shall have cast into the upper surface the word "SEWER" and other lettering and insignias as may be shown on the plans.

02224.2.2.4 STEPS - Plastic or fiberglass steps reinforced with steel, which conform to ASTM C487 or ASTM C478 standards, shall be installed in all sections of each manhole as shown on the Drawings.

02224.2.2.5 CONNECTIONS - All connections to the manhole with piping shall be made with flexible positive seal, watertight gaskets or boots manufactured by Forsheda NPC, Inc., or an approved equal which meets the requirements of ASTM C923.

02224.2.3 PIPELINE LOCATION IDENTIFIERS

Pipeline location identifiers generally take the form of warning tape, and tracer wire. The Contractor shall furnish and install such identifiers as shown on the Drawings and prescribed in these Specifications.

02224.2.4 TRACER WIRE – Tracer wire shall always be installed in the trench with non-metallic pipelines, during or immediately following their installation and may be required in the installation of metallic pipelines where electric conductance is necessary and is not provided through the pipeline because of its type of construction. Tracer wire placement shall be as shown on the Plans but shall generally be immediately beneath (preferred), to the side, or above the pipeline with approximately 4 inches of separation. Tracer wire shall be brought to the surface of the ground at all manholes and where otherwise shown on the plans.

Tracer wire shall be installed as shown in the Plan details. Where splices in the wire are required, the Contractor shall use the manufacturer recommended splice nut (cap) to provide a watertight joint. Extend electrical tape well over the wire insulation in all directions.

The Contractor shall provide all necessary labor, equipment, and materials to perform an electrical continuity test prior to acceptance on all installed tracer wire. The test shall be performed in the presence of the Engineer or an appointed representative. The continuity test shall be conducted using an ohmmeter. Continuity must be demonstrated to pass the test. In the event of a failed test, the Contractor shall make all necessary repairs required to provide a tracer wire system that complies with the testing requirements of this section.

Some soil conditions and/or installation circumstances may require the additional installation of cathodic protection for the tracer wire. When this is the case, cathodic protection will appear as a separate bid item and details for its installation will appear on the Plans and elsewhere in these Specifications.

02224.2.5 **WARNING TAPE** – A continuous ribbon of warning tape shall be installed during the backfill operation. Tape shall be placed a minimum of 12-inches above the top of the pipeline or at a depth approved by the Engineer, or otherwise as shown on the drawings. At roll ends and at places where the tape has been broken, the loose ends shall be tied together to prevent separation during the rest of backfill.

02224.3 CONSTRUCTION REQUIREMENTS

02224.3.1 HANDLING AND APPROVAL OR REJECTION OF MATERIALS

Care shall be taken during unloading and hauling to avoid impact which might damage the pipe. Pipe dropped during unloading shall not be installed unless approved by the Engineer and may be rejected by the Engineer. Pipe will be carefully inspected in the field before and after laying. If any cause for rejection is discovered in a pipe after it has been laid, it shall be removed and replaced by the Contractor at no additional cost to the Owner. Any pipe which is found to be unfit or is rejected due to cracks, broken bells or spigots, chipped exterior or lining, etc., shall be removed from the job site.

02224.3.2 TRENCHING

Excavation and backfill of trenches for sewer piping and manholes shall be performed in accordance with Section 02200 – “Trench Excavation and Backfill” of these Specifications.

02224.3.3 PIPE INSTALLATION

02224.3.3.1 **DEWATERING** - Prior to pipe laying and jointing, when water is present in the trench, sufficient de-watering effort shall be made to maintain the water level at or below the surface of the trench bottom or the base of the bedding course. The de-watering operation; however accomplished, shall be carried out in such a manner as not to permanently disturb natural groundwater conditions.

02224.3.3.2 **CONNECTION TO EXISTING WORK** - When connections are to be made to any existing pipe, conduit, or other appurtenance for which the actual elevation or position cannot be determined without excavation, the Contractor shall excavate for, and expose the existing pipe conduit, etc., before laying any new pipe or conduit. The Contractor shall furnish and install the necessary couplings, fittings, etc., needed to accomplish the cutting in, or connections, whether or not specifically indicated on the Drawings.

The Engineer shall be allowed to inspect the existing pipe or conduit before any connection is made. The Engineer may then make adjustments as required in the line and grade to accomplish the intent shown on the Drawings.

02224.3.3.3 PIPE JOINING – Pipe joining shall be as follows:

- When making connections, pipe shall be cut in a neat and workmanlike manner and beveled so as to provide a smooth end at right angles to the axis of the pipe. Pipe and fittings shall be assembled so there will be no distortion or springing of the pipelines. Care must be taken to properly align the pipe before joints are forced home.
- Where fusion of polyethylene pipe joints is required, sections of pipe shall be joined in a continuous length on the job site above ground. Joining shall be by the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. Equipment used for butt fusion joining shall be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements, alignment, and fusion pressures.
- PVC pipe, 2 inches and smaller in diameter, shall be joined by solvent welding. No disturbance of joints, including from trench backfill operations, will be allowed until solvent welded joints are cured.
- PVC pipe, larger than 2 inches in diameter, shall be joined by means of gasketed joints.
- With bell and spigot joints, care should be taken to properly align the pipe before joints are forced home. Gaskets shall be lubricated in accordance with manufacturer's instructions. During insertion of the spigot end, the pipe shall be partially supported by hand, sling, or crane to minimize unequal lateral pressure on the gasket and to maintain concentricity until the gasket is properly positioned. Since the most flexible gasketed joints tend to creep apart when the end pipe is deflected and straightened, such movement shall be held to a minimum once the joint is home.

02224.3.3.4 PIPE LAYING - All pipe shall be laid to conform to the prescribed line and grade shown on the plans, within specified limits, if any. No blocking of any kind shall be used to adjust the pipe to grade, except when used with concrete embedment. Unless otherwise approved by the Engineer, pipe shall be laid upgrade from the point of connection on the existing pipeline or from a designated starting point. The pipe shall be installed with the bell end forward or upgrade, unless approved otherwise.

The Contractor shall install gravity sewer pipelines at the proper slope by the use of a laser targeting system. Lasers shall be set at the proper slope in manholes and targets shall be affixed at the end of pipe sections being installed. As an alternative to targets, the laser beam may be set at the sewer invert, slope, and elevation. The inside bottom surface of the pipeline will be set directly next to the laser beam. Gravity sewer pipeline alignment shall be a straight line, both vertically and horizontally, between manholes.

All pipe laid shall be retained in position, by mechanical means if necessary, so as to maintain alignment and joint closure until sufficient pipe bedding and backfill have been installed to adequately hold the pipe in place.

02224.3.3.5 PIPE BEDDING - Bedding materials shall be placed so the bottom surface of the pipe will have full bearing for the entire barrel length. The pipe shall rest on not less than 1/4 of its outside perimeter. Bell holes shall be dug as required to assure uniform support along the barrel, but shall be no larger than necessary. After the pipe is laid, additional bedding material shall be placed and compacted in 6-inch lifts to a level even with the spring line of the pipe. The portion of the trench from the spring line to 12 inches above the top of the pipe shall then be filled and compacted in the same way.**02224.3.3.6 COVERING PIPE END - At the close of each workday, or whenever the work ceases for any reason, the end of the pipe shall be securely covered or plugged, unless otherwise permitted by the Engineer.**

02224.3.3.7 CONSTRUCTION NEAR CULINARY WATER LINES - Locate sewer lines at least 10 feet horizontally from any existing or proposed parallel culinary water line. When installation conditions prevent the 10-foot separation, the sewer and water lines may be laid closer, provided

- The elevation of the bottom of the water line is at least 18-inches above the top of the sewer pipe, and
- The water line is laid in a separate trench, or
- The waterline is laid on an undisturbed earth shelf on one side of the sewer line trench, or
- The waterline is laid in a sewer or drainline trench which has been backfilled and compacted to not less than 95% of maximum density determined by ASTM D-690.
- Where culinary water lines and sewer lines cross, either above or below the other, the lines shall be placed:
 - ◆ So as to provide a minimum separation of 18-inches between the top of one line and the bottom of the other;
 - ◆ So that the joints of each are equidistant on either side of the other line with as much separation as possible;
 - ◆ So that, where a sewer line crosses over a water line, the sewer line is adequately supported to prevent it sagging or falling onto the water line and causing damage to it
- In such crossings, where the foregoing vertical and horizontal requirements are impossible to achieve:
 - ◆ The sewer shall be designed and constructed of cast iron, ductile iron, galvanized steel, or other protected steel as approved;
 - ◆ Such construction shall extend for a minimum distance of ten feet on each side of the point of crossing;
 - ◆ Mechanical joints shall be used.
- As an alternative, the Engineer may approve installation of the sewer pipe so that it is fully encased in 12-inch thick concrete for a distance at least 10-feet each side of the crossing.

02224.3.4 PRESSURE PIPE RESTRAINT

02224.3.4.1 THRUST BLOCKS - Thrust blocks and/or mechanical restraints shall be installed on pressure pipelines in accordance with these Specifications and Drawings before any hydrostatic testing is performed on the system. Pressure pipe shall be properly blocked at all fittings whenever:

- The pipeline makes a change in direction of 11 degrees or more,
- It changes size, or
- It terminates (see restraining details in Drawings).

02224.3.4.2 **CONCRETE THRUST BLOCKS** - Concrete thrust blocking shall be formed and placed, so that joints and fittings will be accessible. In addition, all pressure pipe 12" in diameter and larger shall have mechanical restraint furnished and installed at all joints within 60 feet each way from any bend, in addition to thrust blocks shown in the drawings.

02224.3.4.3 **VISUAL INSPECTION** - The Contractor shall allow the Engineer to visually inspect every thrust block before it is buried.

02224.3.5 **MANHOLE INSTALLATION**

02224.3.5.1 **BASES** - Prior to setting the base for manholes, the bottom of the excavation shall be carefully graded to provide uniform bearing and support for the manhole. Where the manhole base is cast in place, all loose material shall be removed and excavation shall be made to assure placement is made on undisturbed soil. Where pre-cast bases for manholes are used, the trench shall be over-excavated at least 6-inches and filled with granular backfill as described herein and compacted and graded to provide uniform bearing and support for the manhole. Where manholes are installed on existing piping, the base may be formed by placing concrete around and under the existing pipe and then cutting away the top one-third of the pipe to form an open channel, after the concrete has been allowed to adequately cure (see invert channels below).

02224.3.5.2 **INVERT CHANNELS** - Invert channels shall be formed from concrete to conform in shape and slope to that of the sewer line. The depth of the channel shall be at least three-quarters that of the diameter of the sewer pipe it serves. Adjacent floor area shall be sloped towards the invert channel to provide a minimum slope of one-inch per foot.

02224.3.5.3 **JOINTS AND CONNECTIONS** - All joints between manhole components shall be made watertight with a permanently flexible sealant. Connections to manholes with new piping shall be made with a rubber boot or seal which will assure a flexible, watertight seal and which conforms to ASTM C923. The connector shall be of a size specifically designed for the pipe material and hole size placed in the wall of the manhole.

02224.3.5.4 **DROP MANHOLES** - Drop sewer manholes shall be constructed in accordance with the details shown on the drawings, whenever a grade difference of more than 18-inches occurs in that manhole. For grade differences of less than 18-inches, the flowline of the manhole base shall be sloped to provide a smooth transition between incoming and outgoing sewer lines.

02224.3.6 **FLUSHING AND CLEANING**

Prior to proceeding with testing, all sewer lines, manholes, and structures and connected piping installed under this Contract shall be flushed and cleaned. The Contractor shall provide all labor, materials, cleaning equipment, and water required to clean the system components.

Upon approval of the Engineer, the Contractor can use standard wastewater system cleaning equipment and methods, such as high-pressure washer systems and suction truck systems, to clean sewer lines and manholes as an alternative to flushing as described below.

Before isolating a specific section of line for flushing, the Contractor shall be responsible for making the necessary arrangements and appropriate piping connections to safely discharge the water used for flushing, to avoid any property damage or contamination of bodies of natural surface or ground water. The Contractor shall fill each section to be tested with clean potable water and then flush the line. The Contractor shall make the necessary arrangements so that a 2.5-foot per second flow velocity will be established in the lines during flushing. Flows required to produce the required flushing velocity indicated above are provided as follows:

FLUSHING FLOW AND VELOCITY

Pipe Diameter (inches)	Flow (gpm) to Produce 2.5 fps
4	100
6	200
8	400
10	600
12	900
16	1600

NOTE: With 40 psi residual pressure, 2 1/2 inch and 4-1/2 inch hydrant outlet nozzles will have the ability to discharge approximately 1,000 GPM and 2,500 GPM respectively.

02224.3.7 TESTING

02224.3.7.1 BACKFILL AND COMPACTION - No testing of any sewer line shall be performed until the trench has been backfilled and compacted to the appropriate unsurfaced grade or level.

02224.3.7.2 FORCE MAINS - Force mains shall be hydrostatically tested according to the requirements of AWWA - 600, Section 4, Hydrostatic Testing of Pipelines for Force Mains.

The Contractor shall furnish all necessary personnel, water, equipment, supplies, and plugging devices required to perform leakage tests as described therein. Any leaks or other deficiencies that are detected shall be repaired and the test section of pipe shall then be re-tested by the Contractor. This process shall be repeated until compliance is achieved.

02224.3.7.3 GRAVITY MAINS - All gravity main sewer piping shall be air pressure tested for exfiltration. Air pressure testing shall be accomplished in accordance with recommended practice (UNI-B-6) of the Uni-Bell PVC Pipe Association for all pipelines less than 36-inches in diameter. Pressure testing will be made at all joints for lines 36-inches or greater in diameter. Testing will be performed with equipment equivalent to that manufactured by Cherne Industrial, Inc. and consistent with the procedure described as follows:

- All wyes, tees, and/or ends of lateral stubs shall be suitably capped and braced to withstand the internal test pressure of the section being tested. Caps shall be easily removable for making future lateral or extension connections.
- Test sections of sewer line shall be isolated by plugging at each manhole with pneumatic plugs. One of the plugs shall be fitted with connections to allow the following:
 - ⇒ Inflation of the pneumatic plug.
 - ⇒ Pressure measurement inside the isolated section of sewer line.
 - ⇒ Introduction of air under pressure into the isolated section of sewer line.
- Air for pressurizing and gauges for measuring pressures shall be supplied through and incorporated into a control panel manufactured specifically for such testing. The control panel shall be fitted with a 3 1/2-inch (or larger), 0 to 30-psi gauge for reading the internal line pressure. Calibrations on the gauge for the 0 through 10-psi range shall be in tenths of pounds.
- Personnel will not be allowed in any involved manhole while pressure is being applied to a test section.

- Air shall be introduced into the test section until the pressure stabilizes at 3.5 psi. Then the time required for the pressure to drop to 3.0 psi shall be observed, recorded, and compared to the following table of acceptability standards:

ALLOWABLE TIME FOR A 0.5 psig TEST PRESSURE DROP IN PVC SEWER PIPE

Pipe Diam. (inches)	Minimum Time in Minutes and Seconds for Various Lengths of Pipe							
	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
6	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
18	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51

If the level of any groundwater present is higher than the level of the test section, the test air pressure shall be increased until it is 4 psi greater than the average backpressure induced on the line by the ground water. At least two minutes shall be allowed for the interior air pressure to stabilize at that pressure. Pressure in the line then shall be observed until it has decreased to 3.5-psi above the groundwater backpressure. The foregoing described test for a 0.5-psi pressure drop can then be commenced.

- Exfiltration testing for all pipe and joints shall be considered acceptable when the time measured for pressure to decrease from 3.5 to 3.0 psi is equal to or greater than the time shown above in the table.

Infiltration testing also shall be conducted for all gravity main sewer lines when the groundwater level is above the top of the pipe section being tested. Tests shall be made by observing and measuring the amount of water infiltration. Testing shall be conducted from manhole to manhole. The length of pipe to be tested shall not exceed 700 feet. The following steps shall be taken as the testing proceeds:

- Measurement of ground water elevation shall be made at the upper and lower ends of the test section and recorded. The upper end of the test section shall then be plugged and the flow of water leaving the lower end will be measured, either by directing the flow into a container of known volume or by observation of flow over a weir.
- Acceptance of the test section for infiltration compliance will be given when the rate of flow out of the section is less than 200 gallons per inch of internal pipe diameter per mile per 24-hour day.

All manholes shall be checked for infiltration by observing their interior surfaces for signs of water infiltration.

02224.3.7.4

DEFLECTION TESTING - All flexible wall sewer piping shall be tested for deflection by passing a mandrel sized to pass through a 5-percent deflection (or deformation) of the pipe section being tested. The Engineer may waive this requirement on short footage projects. Requirements for making such tests are provided as follows:

- Deflection testing shall not be conducted until backfill in the trench has been in place for at least 30 days.
- The test shall be performed by moving the mandrel through the test section without the aid of a mechanical pulling device.

- The mandrel shall be fitted with an odd number of fins or legs (at least nine) which are not worn sufficiently to affect the mandrel's diameter. The fins shall be sized to fit the specific type and size of pipe being tested and shall be stamped by the manufacturer to identify the type and size of pipe. When requested, the Contractor shall provide proof rings to check the mandrel's diameter. The length of the contact edge of the fins shall be at least equal to the pipe's nominal diameter.
- Acceptance of the test section of pipe will be given when the mandrel can pass through that section without stoppage. If stoppage occurs, the pipe shall be excavated and exposed for examination to determine if damage to the pipe has taken place. When pipe damage has occurred, the damaged section shall be removed and replaced by the Contractor. If an obstruction has been caused by deflection, but the pipe is undamaged, the Contractor shall replace the bedding as necessary and carefully re-compact the bedding and backfill. When such corrective measures are completed, the mandrel shall be passed through the test section again to assure compliance.

02224.3.7.5 TESTING DOCUMENTATION - The Contractor shall maintain a record of the procedures performed and the test results for all tests performed on pipelines installed under this Contract. Information contained on the record shall include the following:

- Identification of Contract.
- Contractor's name and name of testing entity, if performed by other than Contractor.
- Name of Test Supervisor.
- Date of test.
- Type of test (air pressure, infiltration, deflection, etc.).
- Identification of test section which includes location, size, and type of pipe.
- Test results (pass/fail, amount of leakage, etc.).
- Description of failure, if any, including reason for failure and corrective measures taken.
- Signature of Test Supervisor.
- Approval signature of Engineer or Engineer's Representative witnessing the tests.

Photocopies of the test documentation shall be provided to the Engineer within 48 hours after the tests are performed and acceptance of the test section is achieved.

02224.3.8 PIPELINE LOCATION IDENTIFIERS

The Contractor shall furnish and install all pipeline location identifiers as called for on the Plans.

02224.3.9 CLEANUP

Following acceptance of testing and completion of backfilling and surface restoration, the Contractor shall prepare the work for contract closeout in accordance with Section 01200 of these Specifications.

02224.4 METHOD OF MEASUREMENT

02224.4.1 PIPE AND APPURTENANCES

This measurement shall be made using a tape measure or other accurate measuring device to determine the total number of lineal feet of pipe in place and accepted. Measurement of pipe shall be made from inside of manhole connection to inside of manhole connection, or to the outside of other structures, and shall include the lineal measurement of valves, fittings, pipe within casings, etc., that occur in the line. This measurement also shall include all work items necessary to completion of the sewer system such as trench excavation, backfilling, compaction, and testing, as well as "furnish and install" or "install only" items such as pipe and fittings, location markers, tracer wire, and warning tape as required on the Drawings.

02224.4.2 **MANHOLES**

Measurement of manholes shall be made by counting the number of manholes of each of the sizes (diameters) indicated on the Drawings, with drop piping, that have been installed and accepted. Variations in the vertical depth of manholes will not be taken into consideration.

Measurement of drop manholes shall be made in the same manner and shall include the drop piping and appurtenances required for making the drop.

As with pipe, measurement for all manholes shall include all work and materials necessary for the finished, functional, and accepted construction of the manhole.

02224.4.3 **CONNECTIONS TO EXISTING WORK**

Measurement for connections to existing pipe, manholes, or other structures shall be made by counting the number of each type or size of connection made and accepted, as indicated on the Drawings.

02224.4.4 **SERVICE TAPS**

Measurement for service taps shall be made by counting each connection made to a sewer main. Such measurement shall include furnishing and installing the connection fitting, including all labor and materials required to cut and install the fitting to the main, and for the marker placed on the upstream end of the service lateral.

02224.4.5 **SERVICE STUBS**

A tape measure or other accurate measuring device shall be used to determine the number of lineal feet of service stub in place and accepted, measuring from the fitting on the main sewer line (service tap) to the termination point of the service stub at the property line.

02224.4.6 **SERVICE LATERALS**

A tape measure or other accurate measuring device shall be used to determine the number of lineal feet of service lateral, measuring from the end of the service stub at the property line to the termination point of the lateral as constructed in the field.

02224.5 BASIS OF PAYMENT

02224.5.1 The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
<i>(Size)(Type)</i> Sewer Pipe	Lineal Foot
<i>(Size)</i> Manhole	Each
<i>(Size)</i> Drop Manhole	Each
<i>(Size)</i> Connection to Existing <i>(Structure)</i>	Each
Service Tap	Each
<i>(Size)(Type)</i> Service Stub	Lineal Foot
<i>(Size)(Type)</i> Service Lateral	Lineal Foot

02315.1 DESCRIPTION

This section covers the installation of casing pipe in certain situations where the casing pipe is required for safety considerations and/or where it is not possible to install either the casing or the carrier pipe by means of open trench excavation.

02315.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 01510 - Protection of Existing Properties
Section 02200 - Trench Excavation and Backfill
Section 02222 - Waterline Pipe Installation
Section 02224 – Sewer Line Pipe and Manhole Installation
Section 15110 – Pipe and Piping Systems

02315.1.2 SUBMITTALS

Prior to commencing any operations, the Contractor shall submit a complete list of all materials to be used in the work, in accordance with Section 01300. The submittal shall include detailed descriptions and/or drawings which show the pit dimensions, pit bracing, casing pipe, casing spacers, jacking equipment, and method of installing the carrier pipe.

02315.1.3 DEFINITIONS

Casing Pipe - the pipe which is installed to provide a conduit for installation of the carrier pipe within.

Carrier Pipe - the pipe installed inside the casing pipe.

Boring - the procedure used to create an opening in the earth materials in which the casing pipe will be inserted.

Jacking - the procedure used to force the casing pipe into the opening in the earth materials.

Spacers - the devices used to align and support the carrier pipe inside the casing during its placement and when the placement is complete.

02315.2 MATERIALS**02315.2.1 CASING PIPE**

Only welded steel pipe shall be installed as casing pipe under this section. The pipe shall be ASTM A53, Grade B, which conforms to ANSI/AWWA C200. The minimum casing diameter and wall thickness shall be as shown in the following table, if not otherwise specified on the Drawings or in the Special Provisions. Where joint restraint harness is required for bell and spigot carrier pipe, the casing pipe shall be sized according to the harness schedule shown on the Drawings and shall be large enough in diameter to accommodate the harness.

The Contractor may select a greater pipe diameter or wall thickness to accommodate the method of installation, loading involved, site conditions, and possible interference; however, such selection will be made at no additional cost to the Owner. In all cases, the inside diameter of the casing pipe shall be large enough to contain the carrier pipe and approved casing spacers and other required materials and equipment.

**CASING PIPE SPECIFICATIONS
(For applications not requiring joint harness)**

Carrier Pipe Diameter	Casing Pipe Diameter	Casing Wall Thickness
4"	10"	.2500"
6"	12"	.3125"
8"	14"	.3125"
10"	16"	.3125"
12"	18"	.3125"

**CASING PIPE SPECIFICATIONS
(For applications requiring joint harness)**

Carrier Pipe Diameter	Casing Pipe Diameter	Casing Wall Thickness
4"	14"	.3125"
6"	18"	.3125"
8"	20"	.50"
10"	22"	.50"
12"	24"	.50"

Note: Casing pipe diameter must accommodate the joint restraint harness where applicable. When joint restraint harnesses are used, casing pipe minimum diameter and wall thickness will be greater.

02315.2.3 CASING SPACERS

Casing spacers shall be commercially available spacers such as are supplied by Advance Products & Systems of Lafayette, Louisiana; Cascade Waterworks Manufacturing Company of Yorkville, Illinois, or approved equal. Unless required otherwise in the Contract Documents, casing spacers shall be manufactured of stainless steel with polymer bearing surfaces on the runners. They shall be of bolt-on design with a two-piece shell, and shall be installed in accordance with manufacturer's instructions.

02315.2.4 SAND

When called for in the Contract Documents, sand to be used to fill the annular space between the carrier pipe and the casing pipe shall be clean and free of lumps, with 100 percent passing a standard No. 30 sieve.

02315.2.5 CARRIER PIPE

Specifications for the carrier pipe and its appurtenances are given elsewhere in the Contract Documents, particularly in Section 15110 and on the Drawings.

02315.2.6 CAPPING MATERIAL

Temporary casing pipe plugs or end caps may be fabricated from 3/4 inch (minimum) C-DX plywood treated for exterior use, or other suitable material as allowed by the Engineer.

02315.2.7 END SEALS

Carrier pipe to casing pipe end seals shall be installed on both ends of the casing and shall be appropriately sized for the application. Seals shall be as manufactured by Pipeline Seal & Insulator, Inc., or approved equal. Seals shall be of synthetic rubber with stainless steel bands and clamps, suitable for permanent installation in the ground.

02315.3 CONSTRUCTION REQUIREMENTS

02315.3.1 GENERAL

The Contractor shall furnish all materials and labor to place a casing pipe underground and install pipelines in such casing in accordance with the Contract Documents. The casing pipe will be installed by boring, jacking, hammering, or other method as prescribed in the Contract Documents and/or approved by the Engineer.

02315.3.1.1 EXPERIENCE - The Contractor shall have at least 5 years experience with jacking or boring casing pipe installations. If the Contractor does not have the required experience, he may, upon the approval of the Engineer, retain the services of a subcontractor who is qualified to perform this work.

02315.3.1.2 NOTIFICATION AND VISUAL INSPECTION - At least 3 days notice shall be given to the Engineer prior to the start of any casing pipe installation operations. All boring and jacking work shall be performed in the presence of the Engineer, unless the Engineer has granted prior approval to perform such work in its absence.

02315.3.1.3 REGULATORY COMPLIANCE - The Contractor shall comply with the requirements of any affected public agency, railway company, utility company or other applicable affected agency responsible for public safety or improvements which might be endangered by the casing installation.

02315.3.1.4 TRAFFIC CONTROL - In the event that the Contractor is not ready to install the carrier pipe and its appurtenances at the time of completion of installation of the casing pipe, and the operation is inhibiting roadway traffic flow, the earth face at the entrance and terminal shall be supported with plywood bulkheads and the approach trenches will be backfilled. Temporary surfacing shall be placed thereon and the affected portion of the street will then be reopened to traffic. Approach trenches in public streets shall not be permitted to remain open for extended periods of time.

02315.3.2 INSTALLATION

02315.3.2.1 PIT EXCAVATION - The pit excavations for boring or jacking operations shall be adequately shored to safeguard existing substructures and surface improvements and to ensure against ground movement in the vicinity of the jack supports. The Contractor shall provide adequate space within the excavation to permit the insertion of the lengths of casing to be installed.

02315.3.2.2 WELDERS' QUALIFICATIONS - All welding shall be done by welders qualified under the provisions of ANSI/AWS D1.1. Qualification shall have been performed by an approved, independent, testing agency not more than 6 months prior to commencing work. Welding machines and electrodes similar to those to be used on the Project shall have been used in the qualification test. The Contractor shall furnish all material and bear the expense of qualifying welders.

02315.3.2.3 JOINING – Casing pipe section joints shall be butt-welded, unless otherwise approved by the Engineer. Casing pipe ends on both sides of the joint shall be prepared in conformance with the requirements of ANSI/AWS D1.1.

02315.3.2.4 PROTECTION OF CASING PIPE - The Contractor shall protect and preserve the interior surfaces of the casing pipe from damage. As required by the Engineer, the Contractor shall provide and install temporary plugs or end caps on casing pipe to prevent the entrance of insects, animals, water, rock, dirt, or other deleterious material during the time casing pipe ends are left exposed while other work is being done.

02315.3.2.5 JACKING AND BORING - For jacking operations, a steel jacking head shall be fitted in such a manner that it extends around the entire outer surface and projects at least 18-inches beyond the driving end of the steel casing. The jacking head shall not protrude more than ½-inch outside the outer casing surface. The head shall be securely anchored to the casing to prevent any alignment variation during jacking operations.

In opening the hole, the Contractor shall restrict excavation of materials to provide the least clearance necessary to prevent binding, to avoid loss of soil, consequential settlement, and possible damage to overlying structures. To minimize the potential for voids outside the casing, excavation shall be carried out entirely within the jacking head and not in advance of the head. Excavated materials shall be removed from the casing as the installation of the casing progresses. Accumulation of excavated materials within the casing will not be permitted without approval of the Engineer.

The Contractor shall control the application of the jacking pressure and excavation of materials ahead of the casing as it advances to prevent the casing from becoming earthbound or deviating from the required line and grade. Heavy guide timbers, or structural steel or concrete cradles, shall be used to ensure boring and/or jacking alignment. Timbers and structural steel sections shall be anchored to ensure action of the jacks is in line with the axis of the casing. A bearing block, consisting of a timber or structural steel framework, shall be constructed between the jacks and the end of the casing to provide uniform end bearing over the perimeter of the casing to distribute the jacking pressure evenly. In installing the casing pipe, it shall be the Contractor's responsibility to obtain the required alignment and grade for the carrier pipe and to ensure that the carrier pipe does not rest on the casing bottom.

After all equipment and excess excavated materials from the boring and jacking operations have been removed from the jacking pit, the Contractor shall prepare the bottom of the pit to serve as a pipe trench bottom in accordance with Section 02200. In doing this, all loose and disturbed materials below pipe grade shall be removed to the level of undisturbed earth, replaced in lifts, and each lift compacted to the appropriate density.

02315.3.2.6 CARRIER PIPE - Upon completion of casing pipe installation, the Contractor shall proceed with installation of the carrier pipe and area cleanup.

The carrier pipe MUST be installed in the casing in such a manner that sufficient carrier pipe extends from each end of the casing pipe to allow for appropriate joining and so as not to interfere with other work such as filling of the annular space. For this purpose, the Contractor shall leave a minimum of 5 feet of carrier pipe exposed at each end of the casing or as otherwise directed by the Engineer.

Mechanical restraint shall be installed on every joint of rubber gasket (slip) jointed carrier pipe installed in the casing pipe.

When required, testing of the carrier pipe shall be completed prior to the filling of the annular space between the casing and carrier pipe with sand. Testing of the carrier pipe shall be made in conformance with specifications outlined in Sections 02222 and 02224.

02315.3.2.7 END SEALS – As shown on the Drawings and/or required in the Special Provisions, the Contractor shall furnish and install permanent casing pipe to carrier pipe end seals. The Contractor shall coordinate this work to assure that seals are appropriately installed as the carrier pipe is placed in the casing pipe and before any backfill operations are started.

02315.3.2.8 FILLING OF ANNULAR SPACE - When required, the Contractor shall furnish all necessary sand, equipment, hoses, valves, fittings and labor to backfill the annular space in the casing with

sand after the carrier pipe has been installed. Sand shall be conveyed through a hose and deposited in its final position by air pressure in such a manner as to completely fill all voids. Sand backfill will be considered completed when no more sand can be forced into the annular space.

02315.4 METHOD OF MEASUREMENT

The amount of casing pipe required shall be as shown on the drawings or prescribed elsewhere in the Contract Documents. However, casing pipe installation is not a "Lump Sum" item, and, in the event the actual quantities required differ from the amount shown, the difference in lineal feet, either more or less, shall be determined using a tape measure or other accurate measuring device and the Contractor paid according to the unit price on the Bid Schedule. The measurement for casing pipe shall include all other work and materials required to install the casing pipe and the carrier pipe within, such as all excavation including but not limited to boring and catch pits, carrier pipe spacers, sand, backfill, bulkheads, equipment and site clean-up.

Measurement for payment of the corresponding length of carrier pipe shall not be included in the casing pipe measurement. It shall be paid separately.

02315.5 BASIS OF PAYMENT

The accepted quantity will be paid for at the contract unit price for:

PAYMENT ITEM	UNIT
Boring and Jacking (<i>size and type</i>)	Lineal Foot

02319.1 DESCRIPTION

The work specified in this section consists of furnishing and installing underground utilities using the horizontal directional drilling (HDD) method of installation, also commonly referred to as directional boring or guided horizontal boring. This work shall include all services, equipment, materials, and labor for the complete and proper installation, testing, restoration of underground utilities and environmental protection and restoration.

02319.1.1 QUALITY ASSURANCE

The requirements set forth in this document specify a wide range of procedural precautions necessary to insure that the very basic, essential aspects of a proper directional bore installation are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this specification. Adherence to the specifications contained herein, or the Engineer's approval of any aspect of any directional bore operation covered by this specification, shall in no way relieve the Contractor of their ultimate responsibility for the satisfactory completion of the work authorized under the Contract.

02319.1.2 SUBMITTALS

- A. **WORK PLAN:** Prior to beginning work, the Contractor must submit to the Engineer a general work plan outlining the procedure and schedule to be used to execute the project. Plan should document the thoughtful planning required to successfully complete the project.
- B. **EQUIPMENT:** Contractor will submit specifications on directional drilling equipment to be used to ensure that the equipment will be adequate to complete the project.
- C. **MATERIAL:** Specifications on material to be used shall be submitted to Engineer. Material shall include the pipe, fittings, casing spacers, end seals, and any other item that is to be an installed component of the project.

02319.2 EQUIPMENT REQUIREMENTS**02319.2.1 GENERAL**

The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pullback the pipe, a drilling fluid mixing & delivery system of sufficient capacity to successfully complete the installation, a guidance system to accurately guide boring operations and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on

hand to maintain the system in good working order for the duration of this project.

02319.2.2 DRILLING SYSTEM

- A. **DRILLING RIG:** The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull the specified pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pull-back pressure during pull-back operations. The rig shall be grounded during drilling and pull-back operations.
- B. **DRILL HEAD:** The drill head shall be steerable by changing it's rotation and shall provide the necessary cutting surfaces and drilling fluid jets.

02319.2.3 GUIDANCE SYSTEM

The Guidance System shall be of a proven type and shall be setup and operated by personnel trained and experienced with this system. The Operator shall be aware of any magnetic anomalies and shall consider such influences in the operation of the guidance system if using a magnetic system.

02319.2.5 OTHER EQUIPMENT AND MATERIALS

- A. **PIPE ROLLERS:** Pipe rollers, if required, shall be of sufficient size to fully support the weight of the pipe while being hydro-tested and during pull-back operations. Sufficient number of rollers shall used to prevent excess sagging of pipe.
- B. **PIPE RAMMERS:** Hydraulic or pneumatic pipe rammers may only be used if necessary and with the authorization of Engineer.

02319.3 OPERATIONS**02319.3.1 GENERAL**

The Engineer must be notified 48 hours in advance of starting work. The Directional Bore shall not begin until the Engineer is present at the job site and agrees that proper preparations for the operation have been made. The Engineer approval for beginning the installation shall in no way relieve the Contractor of the ultimate responsibility for the satisfactory completion of the work as authorized under the Contract.

02319.3.2 PERSONNEL REQUIREMENTS

All personnel shall be fully trained in their respective duties as part of the directional drilling crew and in safety.

02319.3.3 DRILLING PROCEDURE

- A. **SITE PREPARATION:** Work site as indicated on drawings, within right-of-way, shall be graded or filled to provide a level working area. No alterations beyond what is required for operations are to be made. Contractor shall confine all activities to designated work areas.
- B. **DRILL PATH SURVEY:** Entire drill path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations within the areas indicated on drawings. If contractor is using a magnetic guidance system, drill path will be surveyed for any surface geo-magnetic variations or anomalies.
- C. **ENVIRONMENTAL PROTECTION:** Contractor shall place silt fence between all drilling operations and any drainage, wetland, waterway or other area designated for such protection by contract documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. Contractor shall adhere to all applicable environmental regulations. Fuel or oil may not be stored in bulk containers within 200' of any water-body or wetland.
- D. **SAFETY:** Contractor shall adhere to all applicable state, federal and local safety regulations and all operations shall be conducted in a safe manner. Safety meetings shall be conducted at least weekly with a written record of attendance and topic submitted to Engineer.
- E. **PILOT HOLE:** Pilot hole shall be drilled on bore path with no deviations greater than 5% of depth over a length of 100'. In the event that pilot does deviate from bore path more than 5% of depth in 100', contractor will notify Engineer and Engineer may require contractor to pull-back and re-drill from the location along bore path before the deviation. In the event that a drilling fluid fracture, inadvertent returns or returns loss occurs during pilot hole drilling operations, contractor shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with a viscosity exceeding 120 seconds as measured by a March funnel and then wait another 30 minutes. If mud fracture or returns loss continues, contractor will cease operations and notify Engineer. Engineer and contractor will discuss additional options and work will then proceed accordingly.

- G. REAMING: Upon successful completion of pilot hole, contractor will ream bore hole to a minimum of 25% greater than outside diameter of pipe using the appropriate tools. Contractor will not attempt to ream at one time more than the drilling equipment and mud system are designed to safely handle.
- H. PULL-BACK: After successfully reaming bore hole to the required diameter, contractor will pull the pipe through the bore hole. In front of the pipe will be a swivel. Once pull-back operations have commenced, operations must continue without interruption until pipe is completely pulled into bore hole. During pull-back operations contractor will not apply more than the maximum safe pipe pull pressure at any time. In the event that pipe becomes stuck, contractor will cease pulling operations to allow any potential hydro-lock to subside and will commence pulling operations. If pipe remains stuck, contractor will notify Engineer. Engineer and contractor will discuss options and then work will proceed accordingly.

02319.4 PIPE GRADE

Upon completion of the drilling and pulling operations and prior to the final connections to the the HDPE water line shall be flushed according to Section 02222. Given the nature of horizontal direction drilling it is safe to assume that slight variations in pipeline grade may occur.

02319.4 SITE RESTORATION

Following drilling operations, contractor will de-mobilize equipment and restore the work-site to original condition. All excavations will be backfilled and compacted to 95% of original density. Landscaping will be restored to original.

02319.5 RECORD KEEPING

Contractor shall maintain a daily project log of drilling operations and a guidance system log with a copy given to Engineer at completion of project. As-built drawings shall be certified as to accuracy by contractor.

02319.6 METHOD OF MEASUREMENT

The measurement for the HDPE water line pipe to be installed via boring shall include all other work and materials required to install the HDPE pipe such as all excavation, boring and catch pits, sand, backfill, bulkheads, site cleanup, and all other items associate with boring the HDPE water line.

02319.7 BASIS OF PAYMENT

The accepted quantity will be paid for at the contract unit price for:

PAYMENT ITEM	UNIT
(Diameter”) Bore	Linear Foot

02320.1 DESCRIPTION

This section covers the installation of casing pipe where the casing pipe is required for safety or other reasons but may be installed by open trench excavation.

02320.1.1 RELATED WORK

Section 01300 - Submittals
Section 01510 - Protection of Existing Properties
Section 02105 - Earthwork Materials
Section 02200 - Trench Excavation and Backfill
Section 02222 - Water Pipe Installation
Section 02224 - Sewer Pipe and Manhole Installation

02320.1.2 SUBMITTALS

Prior to commencing any operations, the Contractor shall submit a complete list of all materials to be used in the work, in accordance with Section 01300. The submittal shall include detailed descriptions and/or drawings which show the casing pipe, casing spacers, and method of installing the carrier pipe.

02320.1.3 DEFINITIONS

Casing Pipe - the pipe which is installed to provide a conduit for installation of the carrier pipe within.

Carrier Pipe - the pipe installed inside the casing pipe.

Spacers - the devices used to align and support the carrier pipe inside the casing during its placement and when the placement is complete.

02320.2 MATERIALS**02320.2.1 CASING PIPE**

Casing pipe to be installed in open trenches shall be corrosion resistant concrete, PE, PVC or galvanized steel pipe of the size, class and configuration shown on the Drawings, or prescribed in the Special Provisions.

02320.2.2 CARRIER PIPING

Pipe installed in casing pipe shall be of the size, type and configuration shown on the Drawings, and/or prescribed in the Special Provisions. Mechanical restraints, suitable with the type of joints required for the carrier pipe, shall be provided with the carrier pipe.

02320.2.3 CASING SPACERS

Casing spacers shall be commercially available spacers such as are supplied by Advance Products & Systems of Lafayette, Louisiana, Cascade Waterworks Manufacturing Company of Yorkville, Illinois, or approved equal. Unless required otherwise in the Contract Documents, casing spacers shall be manufactured of stainless steel with polymer bearing surfaces on the runners. They shall be with a bolt-on design with a two piece shell, and shall be installed in accordance with manufacturer's instructions.

02320.2.4 SAND

When called for to be installed in the annular space around the carrier pipe, sand shall be clean and free of lumps, with 100 percent passing a standard No. 30 sieve.

02320.2.5 CONCRETE

Shall be Class 2000 as described in Section 3050 when used as encasement and Class 3500 when used as entrance or exit protective structures to any encasement.

02320.2.6 CONCRETE REINFORCEMENT

Shall be materials conforming to, and placed in accordance with. Section 03200 and the details shown on the Drawings.

02320.2.7 CAPPING MATERIAL

Temporary casing pipe plugs or end caps may be fabricated from 3/4 inch (minimum) C-DX plywood treated for exterior use, or other suitable material as allowed by the Engineer.

02320.2.8 END SEALS

Carrier pipe to casing pipe end seals shall be installed on both ends of the casing and shall be appropriately sized for the application. Seals shall be as manufactured by Pipeline Seal & Insulator, Inc., or approved equal. Seals shall be of synthetic rubber with stainless steel bands and clamps, suitable for permanent installation in the ground.

02320.3 CONSTRUCTION REQUIREMENTS**02320.3.1 GENERAL**

The Contractor shall furnish all materials and labor to place a casing pipe underground and install pipelines in such casing in accordance with the Contract Documents. The casing pipe will be installed by open trenching as prescribed in the Contract Documents and/or approved by the Engineer.

02320.3.1.1 NOTIFICATION AND VISUAL INSPECTION - At least 3 days notice shall be given to the Engineer prior to the start of any casing pipe installation.

02320.3.1.2 REGULATORY COMPLIANCE - The Contractor shall comply with the requirements of any affected public agency, railway company, utility company or other applicable affected agency responsible for public safety or improvements which might be endangered by the casing installation

02320.3.1.3 TRAFFIC CONTROL - In the event that the Contractor is not ready to install the carrier pipe and its appurtenances at the time of completion of installation of the casing pipe, and the operation is inhibiting roadway traffic flow, the earth face at the entrance and terminal shall be supported with bulkheads and the approach trenches will be backfilled. Temporary surfacing shall be placed thereon and the affected portion of the street will then be reopened to traffic. Approach trenches in public streets shall not be permitted to remain open for extended periods of time.

02320.3.2 INSTALLATION

02320.3.2.1 EXCAVATION - The Contractor shall prepare the bed for the casing pipe by excavating in to the lines and grades shown on the Drawings in accordance with Section 02200. Laying of the casing pipe shall then be made in accordance with Section 02222 or 02224 as applicable according to the type of pipe required.

02320.3.2.2 CASING PIPE - The casing pipe shall be completely installed and backfilled, unless directed otherwise by the Engineer, before installation of the carrier pipe is started. It shall be the Contractor's responsibility to obtain the required alignment and grade for the carrier pipe and to ensure that the carrier pipe does not rest on the casing bottom.

When the ends of plastic casing pipe are left exposed for future insertion of carrier pipe, galvanized corrugated steel pipe of the appropriate diameter shall be slid over the end of the carrier pipe. The galvanized pipe shall be of sufficient length to cover the end of the plastic casing to a minimum of one foot and to extended from the end of the casing to daylight from beneath the earth cover.

02320.3.2.3 PROTECTION OF CASING PIPE - The Contractor shall protect and preserve the interior surfaces of the casing pipe from damage. As required by the Engineer, the Contractor shall provide and install temporary plugs or end caps on casing pipe to prevent the entrance of insects, animals, water, rock, dirt, or other deleterious material during the time casing pipe ends are left exposed while other work is being done.

02320.3.2.4 END SEALS – As shown on the Drawings and/or required in the Special Provisions, the Contractor shall furnish and install permanent, casing pipe to carrier pipe end seals. The Contractor shall coordinate this work to assure that seals are appropriately installed as the carrier pipe is placed in the casing pipe and before any backfill operations are started.

02320.3.2.5 CONCRETE ENCASEMENT - When encasement in concrete is required, the Contractor shall set the carrier pipe in place in compliance with the Drawings and then form and place concrete encasement in accordance with the Drawings and with Sections 03050, 03100 and 03200 in these Specifications.

02320.3.2.6 CARRIER PIPE - Upon completion of the encasement, the Contractor shall proceed with installation and cleanup of the lines connecting the carrier pipe

Mechanical restraint shall be installed on every joint of rubber gasket (slip) jointed carrier pipe installed in the casing pipe.

The carrier pipe MUST be installed in the casing in such a manner that sufficient carrier pipe extends from each end of the casing pipe to allow for appropriate joining and so as not to interfere with other work such as filling of the annular space. For this purpose, the Contractor shall leave a minimum of 5 feet of carrier pipe exposed at each end of the casing or as otherwise directed by the Engineer.

Testing of that part of the carrier pipe to be encased shall be made at the same time as testing of contiguous portions of the carrier pipe. Testing shall conform to testing requirements stated in Sections 02222 and 02224 as appropriate. For concrete encasement, testing of the carrier pipe shall take place prior to the concrete being placed. For pipe encasement, testing shall be completed prior to the filling of the annular space between the casing and carrier pipe with sand.

After the carrier pipe has been tested and accepted, end seals or other approved covers shall be installed over the ends of the casing pipe to prevent foreign materials from entering the casing while backfilling takes place.

- 02320.3.2.7 **FILLING OF ANNULAR SPACE** - When required for pipe encasement, the Contractor shall furnish all necessary sand, equipment, hoses, valves, fittings and labor to backfill the annular space in the casing with sand after the carrier pipe has been installed. Sand shall be conveyed by air pressure through a hose and deposited in its final position in such a manner as to completely fill all voids. This work will be considered completed when no more sand can be forced into the annular space.

02320.4 METHOD OF MEASUREMENT

02320.4.1 **METAL PIPE ENCASEMENT**

The amount of casing pipe required shall be as shown on the drawings or prescribed elsewhere in the Contract Documents. However, casing pipe installation is not a "Lump Sum" item, and, in the event the actual quantities required differ from the amount shown, the difference in lineal feet, either more or less, shall be determined using a tape measure or other accurate measuring device and the Contractor paid according to the unit price on the Bid Schedule. The measurement for casing pipe shall include all other work and materials required to install the casing pipe and the carrier pipe within, such as all excavation including but not limited to boring and catch pits, carrier pipe spacers, sand, concrete, backfill, bulkheads, equipment and site clean-up together with all other materials and labor required for accepted installation. Measurement for pipe encasement includes backfilling of road sections to the top of the sub-grade.

02320.4.2 **CONCRETE ENCASEMENT**

Measurement of Concrete Pipe Encasement will be made by counting the number of cubic yards of concrete placed to encase the carrier pipe as required, and shall include forming, reinforcement, insertion of carrier pipe, and excavation and backfill of the trench. Measurement for concrete encasement includes backfilling of road sections to the top of the sub-grade.

02320.4.3 **SEPARATE MEASUREMENTS**

Measurement for payment of the length of carrier pipe within the encasement shall be separate from and in addition to measurement of the encasement. Measurement of base gravel and surfacing materials will be separate and according to bid items for those materials.

02320.5 BASIS OF PAYMENT

The accepted quantity will be paid for at the contract unit price for:

PAY ITEM	UNIT
Piped Encasement (casing size and type)	Lineal Foot
Concrete Pipe Encasement	Cubic Yard

Separate payment for furnishing and installing the carrier pipe shall be made under other bid items.

02500.1 DESCRIPTION

This work includes removal and restoration of existing features, public or private, including but not limited to asphalt or concrete pavement, concrete structures, curb and gutter, sidewalk, gravel surfacing, driveways, crosswalks, landscaping, field crops, irrigation ditches, fences, culverts, buried or exposed utilities, abandoned utilities, small utility buildings and the disposal of resulting waste materials and debris.

02500.1.1 RELATED WORK

Section 01510 - Protection of Existing Properties
Section 02015 - Clearing and Grubbing
Section 02200 - Trench Excavation and Backfill
Section 02511 - Hot Plant Mix Bituminous Surfacing
Section 02520 - Pavement Cutting
Section 02900 - Landscaping

02500.1.2 SUBMITTALS

When any improvement not owned by the Owner is designated for restoration work, then, upon completion of such restoration, the Contractor shall obtain a written statement of acceptance or release from the responsible owner of the feature. This statement, in turn, will be submitted to the Engineer for his review and approval prior to acceptance of the work for payment.

02500.1.3 DEFINITIONS

Not used.

02500.2 MATERIALS**02500.2.1 GENERAL**

When restoration of a feature is indicated in the Contract Documents, such work shall be accomplished so as to restore the feature to its original, or better, condition and/or function as it existed prior to removal.

It is recognized that exact duplication of materials cannot always be achieved, but reasonable effort is expected from the Contractor to restore the feature with materials which will provide the same or better service and appearance as observed prior to removal.

All materials shall be new.

02500.2.2 BITUMINOUS SURFACE

02500.2.2.1 PRIMER OR TACKER COAT – Shall be an approved bituminous material such as type MC-70-250, SS1, or CS-1.

02500.2.2.2 PATCHING AND REPAIR - Plant mix material that meets or exceeds the requirements of Section 02511 herein, or of the local State Department of Transportation for asphalt surface road repair, shall be used for patching and repair.

02500.2.2.3 SURFACING – Shall be hot or cold mix bituminous surfacing, meeting or exceeding the requirements of Sections 02511 or 02512 herein, or of the local State Department of Transportation for asphalt surface road repair.

02500.3 CONSTRUCTION REQUIREMENTS

02500.3.1 UNCLASSIFIED REMOVAL AND RESTORATION

02500.3.1.1 EXISTING IMPROVEMENTS - All existing facilities disturbed by the Contractor in prosecution of the Work, including but not limited to asphalt or concrete pavement, concrete structures, curb and gutter, sidewalk, gravel surfacing, driveways, crosswalks, landscaping, field crops, irrigation ditches, fences, culverts, buried or exposed utilities, abandoned utilities, small utility buildings or any other structures or obstructions designated to be removed on the Drawings, by the Engineer, or these Specifications, shall be removed, cleaned up, and then restored or replaced in kind by the Contractor in new condition.

02500.3.1.2 ADJACENT IMPROVEMENTS - Care shall be exercised in such removal to assure that adjacent facilities or structures, which are to remain, are not disturbed. Any damage to such existing facilities or structures resulting from carelessness or negligence on the Contractor's part shall be satisfactorily restored to new condition at the Contractor's expense.

02500.3.1.3 VEGETATION - Trees, shrubs, and other landscape plants designated to be saved for replanting shall be carefully removed, bundled, set aside and protected for replanting by the Contractor. Turf Sod to be saved for replanting shall be removed by machine cutting. In lieu of removal and replacement of turf sod or field crops, the Contractor may, upon approval of the property owner, remove and replant the same. Such agreements shall be documented on the final property release to be signed by the property owner.

Replanting of landscape items shall be performed in accordance with Section 2900.

02500.3.2 TOPSOIL

02500.3.2.1 REMOVAL AND PROTECTION - In all construction areas where re-growth of vegetation is desired, and when called for by the Contract Documents, the Contractor shall remove, segregate, stockpile, store, and protect topsoil during excavation in accordance with Section 02900. Topsoil shall be kept free from contamination from foreign materials and other soils. The Contractor shall arrange construction activities to avoid damage or disturbance to the stockpiled soil.

02500.3.2.2 REPLACEMENT - When backfill operations have been completed, the topsoil shall be replaced and restored to the original contours or as called for on the Drawings, in accordance with Section 2900 of these Specifications.

02500.3.3 GRAVEL SURFACE

02500.3.3.1 REMOVAL - When restoration of graveled driveways, roadways, or parking areas is required, the existing gravel surfacing shall be graded off and stockpiled safely away from ongoing work activities, to prevent contamination with subsurface materials. It may then be reapplied and compacted during restoration activities.

02500.3.3.2 RESTORATION - Areas to be restored shall be backfilled and graded to uniform lines and compacted to the density prescribed for trenching in Section 02200. Existing gravel surfacing materials shall then be replaced in uniform 3 inch layers compacted to 95% of maximum density. After compaction, the affected area shall be graded smooth. Sufficient new material of equal or better quality shall be applied and mixed in, to replace materials lost during prosecution of the Work, to ensure a 3-inch minimum gravel cover after compaction and grading.

02500.3.4 BITUMINOUS SURFACE

02500.3.4.1 REMOVAL - Bituminous pavement surface shall be removed and restored in accordance with this paragraph unless provisions for restoration are made in other Sections of these Specifications. The pavement surface, public or private, designated for removal shall be removed to neat lines, which shall be cut in accordance with Section 02520. No ripping or rooting will be permitted outside of the limits of the cut lines.

Existing driveways, sidewalks, etc., which do not match the new finish grade as shown on the Drawings, also shall be removed preparatory to restoration work.

02500.3.4.2 DISPOSAL - Surfacing materials removed shall be disposed of in accordance with Section 1520 of these Specifications, and will not be permitted in the backfill, except as specifically authorized by the Engineer and in accordance with local requirements.

02500.3.4.3 RESTORATION – Restoration of bituminous surface shall proceed according to the following steps:

- First, the sub-grade shall be graded to a uniform surface, and 6 inches of Untreated Base Coarse (UBC) gravel shall be placed over the area in lifts not thicker than 3 inches, compacted to 95% of its maximum density.
- Then, the exposed edges of existing pavement shall be primed with a material approved for this purpose.
- Unless shown otherwise on the drawings or required otherwise by the Engineer, hot or cold mix bituminous surfacing shall be spread and compacted in individual, 3-inch maximum lifts over the base course. Minimum thickness of the new bituminous surfacing layer shall be equal to the adjacent surface thickness, but shall be not less than 3 inches thick when compacted to 95% of its maximum density.
- Rolling operations shall be conducted in such a manner that shoving or distortion will not develop beneath the roller. The surface shall be finished to a smooth, uniform line and grade with surface deviations not exceeding plus or minus 1/4 inch in 10 feet, unless the surface is subject to more stringent State, County, or Municipal requirements. The determination of smoothness compliance may be made with a straight edge or string line at the option of the Engineer. Any irregularities shall be satisfactorily corrected at the sole expense of the Contractor.
- Existing driveways, sidewalks, etc., which were removed because they did not match the new finish grade, shall be replaced and restored to their original or better condition to match the new finish grade shown on the Drawings, or as directed by the Engineer.

02500.3.5 REMOVAL AND RESTORATION OF CONCRETE IMPROVEMENTS.

02500.3.5.1 REMOVAL - Existing concrete pavement in streets, alleys, driveways, sidewalks, etc., public or private, shall be cut in accordance with Section 02520, and removed to the lines indicated on the Drawings, or as directed by the Engineer. No ripping or rooting will be permitted outside of the limits of saw cut lines.

Existing driveways, sidewalks, etc., which do not match the new finish grade as shown on the Drawings, also shall be removed preparatory to restoration work.

02500.3.5.2 DISPOSAL - All materials removed shall be disposed of in accordance with Section 1520 of these Specifications, and will not be permitted in the backfill, except as specifically authorized by the Engineer and in accordance with local codes.

02500.3.5.3 RESTORATION - Sub surface preparations shall be the same as those in paragraph 02500.3.4.3 above.

- Concrete pavement including sidewalks, driveways, roadways, and parking area surfacing shall be replaced by the Contractor in accordance with Division 3 of these Specifications, unless otherwise directed by the Engineer
- Those existing driveways, sidewalks, etc., which were removed because they did not match the new finish grade, shall be replaced and restored to their original or better condition to match the new finish grade shown on the Drawings, or as directed by the Engineer.
- All other concrete improvements shall be restored in accordance with details shown on the Drawings, or as directed by the Engineer, and as required by the provisions of Division 3 of these Specifications.

02500.3.6 REMOVAL AND RESTORATION OF FENCES

When necessary to remove any fence to facilitate its operation, the Contractor shall obtain prior agreement with the owner of the fence for its removal. Temporary containment measures shall be provided, if needed, at no additional expense to the Owner. As soon as practical, the permanent fence shall be restored to its original condition or better.

02500.3.7 RESTORATION OF IRRIGATION DITCHES

Restoration of irrigation ditches shall be made in such a manner that the ditch configuration and size will be equivalent to its original condition and the ditch will be located on its original alignment. Any embankment required to restore the original slope of the ditch will be layer compacted with mechanical compaction equipment to 90% of maximum dry density determined by AASHTO T-99.

02500.3.8 CLEANUP

Areas of construction activity shall be left in a condition of uniform grade, blending into pre-existing contours and concealing, as much as possible, evidence of construction activity by back dragging or raking to conceal tire marks. Cleanup and disposal of surplus materials shall be performed in accordance with Section 1520.

02500.4 METHOD OF MEASUREMENT

02500.4.1 NO BID SCHEDULE LINE ITEM

When the Bid Schedule in the Contract does not contain a line item for "Removal and/or Restoration of Surface Improvements", then this work will be considered incidental to other items included in the Bid Schedule, and no separate measurement shall be made for this work.

02500.4.2 "DESIGNATED AREA" LINE ITEM

Measurement for removal and/or of surface improvements in a designated area shall be the "lump sum" of the work required to remove and properly dispose of materials resulting from removal.

02500.4.3 “DESIGNATED FEATURE” LINE ITEM

Measurement for removal and/or restoration of designated features shall be per unit as described in the Bid Schedule.

02500.4.4 BITUMINOUS SURFACE PAY LIMIT

Measurement for bituminous surface removal and replacement shall be made by multiplying the pay limit by the actual length of removal and replacement in lineal feet as determined using a tape measure or other accurate measuring device.

In general, for pipe trench excavation, the pay limit shall be determined by the formula $W = OD + 18$ inches (pay limit width equals pipe outside diameter plus 18 inches), rounded up to the nearest standard bucket width. Actual measurement may be modified according to information indicated on the Drawings or as directed by the Engineer.

The pay limit for removal of bituminous surface for other purposes shall be as shown on the Drawings or directed by the Engineer.

02500.4.5 DAMAGED ITEMS

Measurement of items damaged or removed as a result of the Contractor’s negligence shall not be allowed and no payment will be made under this contract.

02500.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit prices as follows:

PAY ITEM	UNIT
Removal of Site Surface Improvements	Lump Sum
Removal of (<i>Name of Structures</i>)	Each
Removal of Sidewalk	Square Yard
Removal of Fences	Lineal Foot
Removal of Driveway Slabs	Square Yard
Removal of Curb and Gutter	Lineal Foot
Removal of Bituminous Surface	Square Yard
Replace (<i>Name of Structure</i>)	Each
Replace (<i>Thickness</i>) Sidewalks	Square Yard
Replace (<i>Thickness</i>) Driveway Slabs	Square Yard
Replace (<i>Thickness</i>) Bituminous Surface	Square Yard
Replace (<i>Description</i>) Fence	Lineal Foot
Replace (<i>Description</i>)	Lineal Foot or Lump sum
Restore (<i>Description</i>)	Lineal Foot or Lump Sum

02510.1 DESCRIPTION

This section covers all sampling and testing of subgrade and pavement materials. The materials sampling and testing shall be done by an independent certified testing company and all testing reports shall be submitted to the Engineer within a reasonable time period.

02510.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 02200 – Trench Excavation and Backfill
Section 03050 – Portland Cement Concrete

02510.1.2 SUBMITTALS

All sampling and test reports shall be submitted in accordance with Section 01300.

02510.1.3 DEFINITIONS

Not used.

02510.2 MATERIALS

Not used.

02510.3 CONSTRUCTION REQUIREMENTS

02510.3.1 TESTING

The minimum testing requirements are as follows: All Materials sampling and testing shall be done by an independent certified testing company and all testing reports shall be submitted to the Engineer within a (2) two week time period or sooner.

02510.3.1.1 EMBANKMENT

- Maximum Laboratory Density 1 test in each soil type
- Field Density and Moisture 1 test per 2000 square yards

02510.3.1.2 BACKFILL

- Field Density and Moisture 2 tests per culvert or structure
(Refer to Section 02200 for Trench Excavation and Backfill Testing)

02510.3.1.3 UNTREATED BASE COURSE

- Sieve Analysis 1 test per production day
- Maximum Laboratory Density 1 test per 10,000 tons
- Field Density and Moisture 1 test per 2000 square yards

02510.3.1.4 ASPHALT CONCRETE PAVEMENT

- Mix design (ASTM 1559 and AASHTO T-283) 1 mix design for the project
- Asphalt temperature As necessary to assure compliance
- Gradation and Asphalt Content 2 tests per production day
- Field Density 1 test per 1600 square yards

- Mix and Laydown Temperature As necessary to assure compliance
- Thickness 1 test per 1600 square yards

02510.3.1.5 PORTLAND CEMENT CONCRETE

- Slump Test 1 test per load of concrete
- Air Test 1 test per load of concrete
- Strength Test 1 compressive strength per 50 cubic yards

02510.4 METHOD OF MEASUREMENT

Measurement for this pay item will be by the lump sum.

02510.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price:

PAY ITEM	UNIT
Materials Sampling and Testing	Lump Sum

02511.1 DESCRIPTION

Includes manufacturing, transporting, laying and compacting hot mixtures of bituminous surfacing for roads, parking areas, sidewalks and other traffic surfaces.

02511.1.1 RELATED WORK

Section 02500 – Removal and Replacement of Surface Improvements
Section 02513 - Asphalt Tack Coat

02511.1.2 SUBMITTALS

02511.1.2.1 MIX DESIGN - The Contractor shall develop and submit proposed mix-designs based on the Marshall Method for Hot Asphalt Paving Mixtures as established in AASHTO T 245. The submittal shall include a laboratory report incorporating all of the information required by that specification, together with curves developed from the mix designs showing varying percentages of asphalt by dry weight of mix versus unit weight, percent air voids, stability, flow and percent voids in mineral aggregate.

02511.1.2.2 JOB MIX FORMULA – At least 15 days prior to producing bituminous mixtures, the Contractor shall submit to the Engineer, in writing, a proposed job-mix formula for each mixture for use in setting the job-mix formula to be used with the proposed materials. For bituminous mixtures, the proposed job-mix formula shall be based on a mix-design-run on aggregates, crushed or otherwise, produced for the project and using the bituminous material that will be furnished for the project.

Each job-mix formula shall propose definite single values (hereafter referred to as Target Values or TV) for:

- The percentage of aggregate passing each specified sieve based on the dry weight of aggregate. These percentages shall be within the range shown in Table 2-H.
- The percentage of bituminous material to be added based on the total weight of mixture.
- The temperature of the mixture as it leaves the mixer.
- The temperature of the mixture placed on the road immediately preceding initial compaction of the mixture.
- The kind and percentage of additives to be used (Hydrated lime may be added to prevent stripping).
- The kind and percentage of mineral filler to be used.
- The percentage of water, based on the total dry weight of mixture.
- The maximum specific gravity of dense graded hot mix bituminous paving mixtures as determined by AASHTO T 209 (For open graded hot mixes, the laboratory density developed during mix design shall be used as the TV. It shall be the maximum density for the TV bituminous content).
- The mixture shall have a minimum dry retained strength value of 200 psi.

After reviewing the Contractor's proposed job-mix formula, the Engineer shall determine a job-mix formula with single values for the nine parameters listed above, and so notify the Contractor in writing.

Should a change in source of material be proposed, or should a job-mix formula prove unsatisfactory, the Contractor shall establish a new job-mix formula and shall submit same to the Engineer.

02511.1.2.3 **PENETRATION/VISCOSITY/TEMPERATURE RELATIONSHIPS** - The Contractor shall submit penetration/viscosity/temperature relationships for the bituminous material to be used in the Work along with a certification from the supplier attesting to their accuracy. If the supplier finds it desirable or necessary to change crudes or blends of crudes, new relationships must be supplied along with a sample to use in running a new mix-design. This submittal shall be made not less than 15 days prior to delivery of material from the changed source of materials. The penetration and viscosity values shall be determined at the temperatures and by the procedures specified in AASHTO M 226.

02511.1.3 **DEFINITIONS**

Plant - Stationary machinery used for manufacturing mixtures of asphalt cement, liquid asphalt with aggregate to form a uniform mixture of bituminous surfacing. Sometimes referred to as "batch plant".

Aggregate - Crushed stone, gravel or slag with uniform particle sizes.

Gradation - A group of particle size limits that are prescribed for aggregate.

Job-Mix Gradation - A gradation of aggregate which has been developed by a contractor or material supplier which can consistently be produced from a given source.

Job-Mix Formula - A mixture of asphalt materials and aggregate which can be consistently produced from a given source with the available plant of a contractor or material supplier.

Course - A single layer of bituminous surfacing.

Mat - Single or multiple layers of bituminous surfacing which have been placed.

Lot - The amount of bituminous mixture placed during a production day.

02511.2 MATERIALS

02511.2.1 **ASPHALT CEMENT**

Shall meet the requirements of AASHTO M 20 for penetration-graded asphalt cement and AASHTO M 226 for viscosity-graded asphalt cement. When not shown otherwise, the Contractor shall use viscosity grade AC-20 asphalt cement for the bituminous mixture.

02511.2.2 **AGGREGATES**

Aggregates for hot bituminous mixtures shall be crushed stone, slag or gravel meeting the quality and gradation requirements shown below in Tables 1-H and 2-H, unless shown otherwise in the Contract Documents.

When crushed gravel is used, at least 50 percent by weight of the particles retained on the Number 4 sieve shall have at least one mechanically fractured face.

TABLE 1-H CRUSHED AGGREGATE QUALITY REQUIREMENTS FOR HOT BITUMINOUS PAVEMENT.

Description	AASHTO Test Method	Requirements
Percent Wear	T 96	40 max.
Durability Index, Coarse and Fine	T 210	35 min.
Sand Equivalent (Alternative Method Number 2)	T176	45 min
Stripping Test	T 182	Min. 95% coated**

** An approved chemical additive may be used to meet this requirement.

TABLE 2-H GRADATION LIMITS FOR CRUSHED AGGREGATE USED IN HOT BITUMINOUS SURFACING.

Sieve Size	Percent of Total Aggregate (dry weight)			
	1-inch (1)	¾-inch (2) (Non-rutting)	¾-inch (3)	½-inch (4)
1 inch	100			
¾ inch		100	100	
½ inch	75-91	74-99		100
3/8 inch		69-91	75-91	
No. 4	47-61	49-65	46-62	60-80
No. 8		33-47		
No. 16	23-33	21-35	22-34	28-42
No. 50	12-22	6-18	11-23	11-23
No. 200	5-9	2-6	5-9	5-9

When aggregate is produced and/or stockpiled in more than one size, the blend of sizes shall be based on results of mix design properties that yield the most ideal results. The blended gradations; however, must stay within the gradation limits given herein.

02511.3 CONSTRUCTION REQUIREMENTS

02511.3.1 BITUMINOUS SURFACE MIXING, PLACEMENT, AND FINISHING

02511.3.1.1 PLANT DESIGN AND EQUIPMENT - Plants shall be specifically designed and manufactured to produce a uniform bituminous mixture. The plant shall be capable of controlling and accurately proportioning both aggregates and asphalt cement. Automatic controls shall be provided to shut down the plant when a supply of aggregate or bituminous material is not available.

The plant shall be equipped with appropriate dust collectors and/or control equipment, which enable operation of the plant to meet local and State environmental and health requirements. Liquids from a wet scrubber, when used, shall not be discharged into live streams, lakes or ponds. Effluent from such equipment shall be collected and deposited according to applicable State and local requirements.

Thermometers shall be installed in the plant to accurately indicate the temperature of the bitumen at the charging value in the mixer unit and at the discharge chute of the mixer unit.

Accurate weight measurement of ingredients is essential. Bituminous mix plants shall have associated weight measurement equipment (scales, etc.) with an incremental accuracy of not more than 10 pounds to weigh materials.

- 02511.3.1.2 MIXING - The aggregates, bituminous material, additives, mineral filler and water shall be measured or gauged and introduced into the mixer in the amount specified by the job mix formula. The bituminous material shall be evenly heated to the specified temperature. A continuous supply of the bituminous material shall be fed to the mixer at a uniform temperature. The temperatures of asphalt cement delivered to the mixer shall be sufficient to achieve a kinematic viscosity of 150 to 300 centistokes.

Aggregate for pugmill mixing shall be heated, dried, and delivered to the mixing unit at a temperature within $\pm 30^{\circ}\text{F}$ of the temperature of the bitumen, temperature not to exceed 325 degrees F. Moisture content of the aggregate shall not exceed 1 percent at the time it is introduced into the mixing unit. Flames used for drying and heating shall be properly adjusted to avoid damage to, and soot formation on, the aggregate.

After the required amounts of all materials have been introduced into the mixer, the ingredients shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate have been obtained.

- 02511.3.1.3 HAULING - Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds that have been thinly coated with a material to prevent the mixture from adhering to the beds. Truck beds shall not contain any water or deleterious material prior to loading.

The Contractor, at no cost to the Owner, shall provide scales for weighing the vehicles used for hauling the bituminous mixture. If of the required accuracy, these scales may be the same as those used to weigh ingredients at the mix plant. The Contractor shall provide such scales at no additional cost to the Owner

- 02511.3.1.4 PLACEMENT - Except for small areas inaccessible to such equipment, hot bituminous mixtures shall be placed with bituminous pavers. Pavers shall be self-contained, power-propelled units, provided with an adjustable activated-screed or strike-off assembly, heated if necessary, and capable of spreading and finishing courses of bituminous plant mix material in lane widths and thickness' as shown on the Drawings. When shown on the Drawings, pavers shall be equipped with a control system capable of automatically maintaining the proper screed elevation.

Placement of the bituminous mixture shall be continuous. The mixture shall be spread and struck off to the grade and elevation established in the Contract Drawings. Unless otherwise shown on the Drawings, mix shall be placed in lifts which, when compacted, will not exceed 4-inches in thickness.

The longitudinal joint in one layer shall offset that in the layer immediately below by approximately 6-inches, making sure that the joint in the top layer shall be at the center or dividing line of every two-lanes of traveled roadway. Transverse joints in succeeding layers and in adjacent lanes shall be offset at least 10-feet.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable (along forms, curbs, headers, walls and other places), the mixture shall be placed and finished using hand tools and then thoroughly compacted with hot hand tampers, smoothing irons or mechanical tampers.

Bituminous surface shall not be placed when weather conditions prevent proper handling, hauling and placing of the mixture, when the base course is frozen, when the average temperature of the underlying surface is below 35 degrees F, or when the air temperature reaches 50 degrees F and is falling. Placement on water covered surfaces will not be permitted. Subject to the above restrictions, bituminous mixture placement may begin when the air temperature reaches 45 degrees F and is rising.

02511.3.1.5 **COMPACTION** - Compaction shall be performed with vibratory or non-vibratory steel-wheel rollers and pneumatic-tire rollers. Initial breakdown rolling shall be accomplished while the mix temperature exceeds 250° F. Rolling shall be completed before the mix temperature drops to 175° F.

Rollers shall begin at the sides and proceed longitudinally parallel to the road centerline, each trip overlapping 6-inches or two times the pavement depth, whichever is greater, gradually progressing to the center. When paving in echelons or abutting a previously placed lane, the longitudinal joint should be rolled first, then followed by the above rolling procedure. On super-elevated curves, the rolling shall begin at the low side and progress to the high side.

Rollers shall not pass over the unprotected end of a freshly laid mixture. Transverse joints shall be formed by cutting back into the previous run to expose the full depth of the course. Heat shall be applied to contact surfaces of transverse joints just before additional mix is placed against them.

02511.3.2 **EXCESS BITUMINOUS SURFACE MATERIAL.**

Material trimmed from the edges, together with any other discarded bituminous mixture, shall be removed from the roadway and disposed of by the Contractor in an approved area.

02511.3.3 **TESTING**

02511.3.3.1 **CONTRACTOR TESTING** - The Contractor shall be responsible for providing the necessary tests for controlling and maintaining the mixture within the limits indicated in the approved job-mix formula. Sampling and testing will be performed on each lot of material as it is placed. Gradation and asphalt content samples will be taken immediately behind the paver at the following rate:

LOT TESTING

Lot Size –Sq.Yds.	Minimum Number of Samples
1500 and greater	4
Less than 1500	3

Density and thickness samples will be taken at a rate of one sample per each lot of up to 1500 square yards. When lot size exceeds 1500 square yards, two samples will be taken.

Checks for smoothness will be made at locations selected by the Engineer for each lot. Smoothness checks will not be required where design transitions will not allow compliance with the criteria.

Acceptance of bituminous material placed shall be made by comparing test results with the job-mix formula and the dimensions provided in these Specifications. Acceptance of each lot will be given when test results are within the following tolerances:

BITUMINOUS TEST

Test	Maximum Deviation
Asphalt Content	Mean of tests on each lot is less than 1%
Gradation	Mean of tests for any sieve size is less than 10%
Density	Any test is 92% or greater
Thickness	Any test is less than 0.5-inches
Smoothness	0.25-inches in 10-foot longitudinally or transversely

Any corrective measures necessary to bring the bituminous surface into compliance must be made while the surface temperature is still greater than 175° F.

See Subsection 02511.5.2 – PRICE ADJUSTMENTS, below.

02511.3.3.2 ENGINEER TESTING – At his own discretion, the Engineer also may spot-check the bituminous mix for acceptability and for determination of compliance with installation requirements. These spot-checks will not be used for acceptance but for guidance. On request, the results will be made available to the Contractor by the Engineer.

02511.4 METHOD OF MEASUREMENT

02511.4.1 NO SEPARATE MEASUREMENT

No separate measurement shall be made for furnishing and installing bituminous surface when it is an integral component of a structure or facility shown as another line item in the Bid Schedule.

02511.4.2 SEPARATE MEASUREMENT

When bituminous surface is shown as a separate pay item in the Bid Schedule, measurement shall be made by counting and adding together each square yard of surface in place and accepted. This measurement shall include furnishing all necessary materials and equipment, labor, weighing, mixing, hauling, placement, compaction, and testing to produce an acceptable bituminous surface.

02511.5 BASIS OF PAYMENT

02511.5.1 ACCEPTED QUANTITIES

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
(Depth) Hot Plant Mix Bituminous Surfacing	Square Yards

02511.5.2 PRICE ADJUSTMENTS

02511.5.2.1 DEVIATIONS FROM CRITERIA - For deviations from criteria provided by the approved job-mix formula and in these Specifications and Drawings, the unit price shown in the Bid Schedule will be adjusted by application of the pay factor shown in the tables below:

TABLE A - THICKNESS DEFICIENCY

Pay Factor	Average Core Thickness Deficiency (In Inches)
100	0.00 - 0.25
90	0.26 - 0.50
80	0.51 - 0.75
50	0.76 - 1.00
Remove and Replace	More than 1.00

TABLE B - NON-COMPLYING COMPACTION TESTS

Test Method	Pay Factor	Percent Of Bulk Density Target	
		Mean of all Tests	Lowest of all Tests
ASTM D 3203 (Rice Method)	1.00	95 to 100	90 or greater
	0.90	95 to 100	Less than 90
	0.80	92 to 95	90 or greater
	0.50	Less than 92	90 or greater

TABLE C - NON-COMPLYING BITUMEN CONTENT AND AGGREGATE
GRADATION

Criteria	Pay Factor	Mean Deviation Of Number Of Tests In Test Lot									
		1 Test		2 Tests		3 Tests		4 Tests		5 or more Tests	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Bitumen Content	1.00	0.0	0.7	0.0	0.54	0.0	0.46	0.0	0.41	0.0	0.38
	0.975	0.0	0.8	0.55	0.61	0.47	0.52	0.42	0.46	0.39	0.43
	0.95	0.0	0.9	0.62	0.68	0.53	0.58	0.47	0.52	0.44	0.47
	0.90	0.0	1.8	0.69	0.75	0.59	0.64	0.52	0.56	0.48	0.52
	0.85	0.0	1.1	0.76	0.82	0.65	0.69	0.57	0.61	0.53	0.56
½" and larger Sieve	1.00	0.0	10.0	0.0	7.3	0.0	6.3	0.0	5.6	0.0	5.2
	0.975	11.0	12.0	7.4	8.3	6.4	7.1	5.7	6.3	5.3	5.8
	0.95	13.0		8.4	9.3	7.2	7.9	6.4	7.0	5.9	6.4
	0.90	14.0		9.4	10.3	8.0	8.7	7.1	7.7	6.5	7.1
	0.85	15.0		10.4	11.3	8.8	9.5	7.8	8.4	7.2	7.7
3/8" Sieve	1.00	0.0	9.0	0.0	6.9	0.0	5.9	0.0	5.3	0.0	4.9
	0.975	10.0		7.0	7.8	6.0	6.6	5.4	5.9	5.0	5.5
	0.95	11.0		7.9	8.7	6.7	7.3	6.0	6.6	5.6	6.1
	0.90	12.0	13.0	8.8	9.6	7.4	8.0	6.7	7.2	6.2	6.6
	0.85	14.0		9.7	10.5	8.1	8.9	7.3	7.9	6.7	7.2
No. 4 Sieve	1.00	0.0	9.0	0.0	6.7	0.0	5.7	0.0	5.2	0.0	4.8
	0.975	10.0		6.8	7.6	5.8	6.3	5.3	5.8	4.9	5.4
	0.95	11.0		7.7	8.5	6.4	6.9	5.9	6.4	5.5	5.9
	0.90	12.0	13.0	8.6	9.4	7.0	7.5	6.5	7.0	6.0	6.5
	0.85	14.0		9.5	10.2	7.6	8.0	7.1	7.6	6.6	7.0
No. 8 Sieve	1.00	0.0	7.0	0.0	5.6	0.0	4.8	0.0	4.3	0.0	4.0
	0.975	8.0		5.7	6.3	4.9	5.4	4.4	4.8	4.1	4.5
	0.95	9.0		6.4	7.0	5.5	6.0	4.9	5.3	4.6	4.9
	0.90	10.0		7.1	7.7	6.1	6.6	5.4	5.8	5.0	5.4

Criteria	Pay Factor	Mean Deviation Of Number Of Tests In Test Lot									
		1 Test		2 Tests		3 Tests		4 Tests		5 or more Tests	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
	0.85	11.0	12.0	7.8	8.5	6.7	7.2	5.9	6.4	5.5	5.8
No. 16 Sieve	1.00	0.0	7.0	0.0	5.2	0.0	4.6	0.0	4.2	0.0	3.9
	0.975	8.0		5.3	5.8	4.7	5.1	4.3	4.6	4.0	4.3
	0.95	9.0		5.9	6.4	5.2	5.6	4.7	5.1	4.4	4.7
	0.90	10.0		6.5	7.0	5.7	6.1	5.2	5.5	4.8	5.1
	0.85	11.0	12.0	7.1	7.6	6.2	6.6	5.6	5.9	5.2	5.4
No. 50 Sieve	1.00	0.0	6.0	0.0	4.3	0.0	3.8	0.0	3.4	0.0	3.2
	0.975	7.0		4.4	4.8	3.9	4.1	3.5	3.8	3.3	3.5
	0.95	8.0		4.9	5.3	4.2	4.5	3.9	4.1	3.6	3.8
	0.90	9.0		5.4	5.8	4.6	4.9	4.2	4.4	3.9	4.1
	0.85	10.0		5.9	6.4	5.0	5.5	4.5	4.9	4.2	4.5

02511.5.2.2 REMOVAL OF MIX - The Engineer may order the removal of the mix if the mean result of the lot acceptance tests deviate from the job-mix formula for a particular sieve or sieves, or if the asphalt content is more than the values shown under the 0.85 pay factor in Table C. Where material not meeting this criteria is allowed to remain, a pay factor of 0.50 will be applied.

When the tested density percentage pay factor in Table B is multiplied by the pay factor shown in Table C, and the product is less than 0.80, the Engineer may order removal of the mix. Where material not meeting this criteria is allowed to remain, a pay factor of 0.50 will be applied.

02511.5.2.3 ADDITIONAL MIX - When a lot shows a deficient thickness of more than 0.5-inches, the Engineer may order additional material to be placed and additional payment for the material required will be allowed. When excess thickness is determined, the Engineer may allow it to remain in place; however, only 50 percent of the mix in excess of the 0.5-inch tolerance will be paid for.

02511.5.2.4 OPTIMAL ASPHALT CONTENT PERCENTAGE - Optimal asphalt content percentage will be determined from the job-mix formula provided by the Contractor unless the bituminous mixture is obtained from an established commercial asphalt plant. In such case, the optimum percentage may be determined from previous mixes which meet the criteria provided in these Specifications.

02512.1 DESCRIPTION

Includes requirements for furnishing bituminous and aggregate materials, mixing those materials in place on graded surfaces and laying and compacting those mixtures for roads, parking areas, and other traffic surfaces.

02512.1.1 RELATED WORK

Section 02513 - Asphalt Tack Coat
Section 02514 - Asphalt Prime Coat

02512.1.2 SUBMITTALS

Not used.

02512.1.3 DEFINITIONS

Blade - The grading or manipulation of road surfacing materials with a road grader blade.

Aggregate - Crushed stone, gravel or slag with uniform particle sizes.

Gradation - A group of particle size limits that are prescribed for aggregate.

Course - A single layer of bituminous surfacing.

Mat - A single or multiple layers of bituminous surfacing, which have been placed.

02512.2 MATERIALS**02512.2.1 ASPHALT**

The asphalt shall be the type and grade of asphalt shown on the Drawings and shall meet the current requirements contained in the "Standard Specifications for Paving and Industrial Asphalts" issued by the Asphalt Institute. When the asphalt type and grade are not shown on the Drawings, or in these Specifications, MC-70 or MC-250 liquid asphalt will be acceptable.

02512.2.2 AGGREGATE

Aggregate shall be crushed stone, slag or gravel meeting the quality and gradation requirements shown below in Tables 1-R and 2R, unless shown otherwise in the Special Provisions or elsewhere in the Contract Documents. At least 50 percent by weight of the particles retained on the Number 4 sieve shall have at least one mechanically fractured face. Aggregates may be sampled and tested at random and must meet the requirements below. Failure of materials to meet the requirements of these standards may result in rejection of all materials placed prior to the tests.

TABLE 1-R: CRUSHED AGGREGATE QUALITY REQUIREMENTS FOR ROAD-MIX BITUMINOUS PAVEMENT

Description	AASHTO Test Method	Requirements
Percent Wear	T 96	40 max.
Durability Index, Coarse and Fine	T 210	35 min.
Sand Equivalent (Alternative Method Number 2)	T176	45 min.
Stripping Test	T 182	Min. 95% coated**

** An approved chemical additive may be used to meet this requirement.

TABLE 2-R: GRADATION LIMITS FOR CRUSHED AGGREGATE USED IN ROAD-MIX BITUMINOUS SURFACING

Sieve Size	Percent of Total Aggregate (dry weight)
	$\frac{3}{4}$ -inch
$\frac{3}{4}$ inch	100
$\frac{1}{2}$ inch	---
$\frac{3}{8}$ inch	78-92
No. 4	55-67
No. 8	---
No. 16	28-38
No. 50	---
No. 200	7-11

02512.3 CONSTRUCTION REQUIREMENTS

02512.3.1 BITUMINOUS MIXTURE

02512.3.1.1 SCALES - If scales are not available for weighing vehicles used for hauling the aggregate and bituminous material, the Contractor shall provide such scales at no cost to the Owner.

02512.3.1.2 AGGREGATE - When aggregate on the existing surface is to be used for the bituminous mixture, that aggregate shall be scarified to the depth indicated on the Drawings and bladed into a windrow away from the surface being constructed. The exposed surface shall then be uniformly bladed and rolled, or watered and rolled to form a tight, lightly moistened surface.

When new aggregate is to be used for the bituminous mixture, the existing base shall be lightly scarified and bladed to a uniform grade to the dimensions shown on the Drawings. This graded surface shall then be rolled, or watered and rolled, to form a tight lightly moistened surface. Aggregate then shall be placed on the prepared surface and bladed into a uniform section which can be easily measured to check its volume.

If the surface moisture of the aggregate is greater than 3 percent of the dry weight of the aggregate and emulsified asphalt is not being introduced, the aggregate shall be aerated by movement until its moisture content is reduced to 3 percent or less. When an acceptable moisture content is achieved, the aggregate shall be spread into a uniform layer of convenient width for introduction of the bituminous material.

02112.3.1.3 MIXING – Mixing of materials shall be as follows:

- For blade grader mixing, application of bituminous material to the aggregate shall be accomplished with a distributor designed, equipped, maintained and operated so that bituminous material will be applied in successive applications at an even temperature and uniform rate on variable widths of surface up to 12-feet. The distributor must be capable of controlling rates of application from 0.05 to 2.0 gallons per square yard, with uniform pressure and with a variation from the rate set not to exceed 0.02 gallon per square yard. Operable measuring equipment shall be included on the distributor which includes a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring the temperature of the bituminous material in the tank. Asphalt viscosity shall range between 50 and 200 centistrokes at application. Distributors shall be equipped with (1) a power unit for the pump and (2) full circulation spray bars that adjust laterally and vertically.

- Traveling mixers shall not be used to introduce the bituminous material, unless specifically authorized in writing by the Owner. Approval also must be obtained in writing from the Owner before moving the unit to the work site.
- No more than 0.50 gallon of bituminous material shall be applied per square yard in any one application. Partially mix the asphalt material with the aggregate immediately after each application. Windrow and mix the entire surface course after the last application of asphalt by blading the mixture from side to side of the roadway. The mixture shall be blade mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is achieved, and no more than 50% of the original volatiles shall remain in the mix. The mixture shall be uniform in appearance, texture, asphalt content, and free from pockets of segregated aggregates. The Contractor shall not cut into the underlying base course or contaminate the mixture with earth or other foreign matter while mixing.
- Any excess or deficiency of material in the mix shall be corrected by the addition of aggregate or bituminous material as appropriate and the bituminous mixture re-mixed until it meets requirements. Should the mixture show an uneven distribution of materials, the materials shall be re-mixed until this condition is corrected.

02512.3.2 PLACEMENT

02512.3.2.1 SPREADING - The spreading of the mix shall not be started until the surface to be covered is approved by the Owner. Form the completed mixture in a windrow of approved cross section and spread in a single course to the plan elevations, grades, and cross sections.

02512.3.2.2 WINDROWING MATERIAL AT DAY'S END - At the end of each day's work or if work is halted for other reasons, all loose material shall be bladed into a windrow, whether all mixing is complete or not, and retained in that windrow until operations are resumed. Do not leave non-compacted spread material on the roadbed overnight.

02512.3.2.3 WEATHER CONDITIONS - The bituminous mixture shall not be placed when weather conditions prevent proper mixing and placing of the mixture; when the base course is frozen; or when the average temperature of the underlying surface is below 50° Fahrenheit and air temperature is rising. Placing on water covered surfaces will not be permitted.

02512.3.3 COMPACTION

02512.3.3.1 ROLLING - Steel-wheel rollers and pneumatic-tire rollers shall have a total compacting width of not less than 60-inches and a gross weight adjustable within the range of 200 to 350 pounds per inch of compaction width. All tires on the pneumatic roller shall be equally inflated and have a means of adjusting the contact pressure to suit project conditions. Roll without shoving or distorting the surface.

Initial rolling shall be with the pneumatic-tire roller and final rolling shall be completed with a steel-wheeled roller. Rollers shall begin at the sides and proceed longitudinally parallel to the center of the surface being placed, each trip overlapping 6-inches or two times the pavement depth, whichever is greater, gradually progressing to the center. When paving in echelons or abutting a previously placed lane, the longitudinal joint should be rolled first, then followed by the above rolling procedure. On super-elevated curves, the rolling shall begin at the low side and progress to the high side.

02512.3.3.2 IRREGULAR AREAS - On areas where irregularities or unavoidable obstacles make the use of mechanical equipment impracticable, (along forms, curbs, headers, walls and other places) the

mixture shall be thoroughly compacted with hot hand tampers, smoothing irons or mechanical tampers.

02512.3.3.3 TOLERANCES - Finish to a smooth, uniform line and grade with surface deviations not exceeding plus or minus 3/8-inch in 10 feet.

02512.3.4 TESTING

02512.3.4.1 CONTRACTOR TESTING - The Contractor shall be responsible for providing the necessary tests for controlling and maintaining the mixture within the limits indicated in these Specifications and the Drawings.

02512.3.4.2 OWNER TESTING - The Owner may also make tests for spot-checking acceptability and determination of compliance with installation requirements.

02512.3.4.3 SAMPLING - Sampling and testing will be performed on each lot of material placed. A lot equals the amount of material placed during a production day. When production is less than 500 square yards per day, the Owner may not require sampling and testing.

02512.3.4.4 THICKNESS SAMPLES - Thickness samples will be taken at a rate of one sample per each lot of up to 1500 square yards. When lot size exceeds 1500 square yards, two samples will be taken. Specified thickness standards may be waived if additional thickness is required by the approved Contractor's drawings to level an existing surface.

02512.3.4.5 SMOOTHNESS CHECKS - Checks for smoothness will be made at locations selected by the Owner for each lot. A straight edge or string line shall be used to determine smoothness compliance. Smoothness checks will not be made where transitions or variations will not allow compliance with the criteria.

02512.3.5 EXCESS MATERIAL

Material trimmed from the edges and any other discarded bituminous mixture shall be removed from the roadway and disposed of by the Contractor in an approved manner conforming to State environmental codes and regulations.

02512.4 METHOD OF MEASUREMENT

02512.4.1 NO MEASUREMENT

No separate measurement shall be made for furnishing and installing bituminous mixtures when such materials are components of another structure or facility and not specifically shown on the Bid Schedule.

02512.4.2 SEPARATE MEASUREMENT

When shown as an item in the Bid Schedule, measurement shall be made for each square yard of Road Mix Bituminous Surfacing furnished, mixed, and placed, including asphalt cement, aggregate, additives, etc., used in the mixture.

02512.5 BASIS OF PAYMENT

02512.5.1 ACCEPTED QUANTITIES

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
Road Mix Bituminous Surfacing	Square Yard

02512.5.2 PRICE ADJUSTMENTS

02512.5.2.1 DEVIATIONS FROM CRITERIA

For deviations from criteria provided by the approved job-mix formula and in these Specifications and Drawings, the unit price shown in the Bid Schedule will be adjusted by application of the pay factor shown in the tables below:

TABLE A - NON-COMPLYING BITUMEN CONTENT AND AGGREGATE GRADATION

Criteria	Pay Factor	Mean deviation of number of tests in test lot									
		1 Test Min Max		2 Tests Min Max		3 Tests Min Max		4 Tests Min Max		5 or more Tests Min Max	
Bitumen Content	1.00	0.0	0.7	0.0	0.54	0.0	0.46	0.0	0.41	0.0	0.8
	0.975	0.0	0.8	0.55	0.61	0.47	0.52	0.42	0.46	0.39	0.43
	0.95	0.0	0.9	0.62	0.68	0.53	0.58	0.47	0.52	0.44	0.47
	0.90	0.0	1.8	0.69	0.75	0.59	0.64	0.52	0.56	0.48	0.52
	0.85	0.0	1.1	0.76	0.82	0.65	0.69	0.57	0.61	0.53	0.56
1/2" and larger Sieve	1.00	0.0	10.0	0.0	7.3	0.0	6.3	0.0	5.6	0.0	5.2
	0.975	11.0	12.0	7.4	8.3	6.4	7.1	5.7	6.3	5.3	5.8
	0.95	13.0		8.4	9.3	7.2	7.9	6.4	7.0	5.9	6.4
	0.90	14.0		9.4	10.3	8.0	8.7	7.1	7.7	6.5	7.1
	0.85	15.0		10.4	11.3	8.8	9.5	7.8	8.4	7.2	7.7
3/8" Sieve	1.00	0.0	9.0	0.0	6.9	0.0	5.9	0.0	5.3	0.0	4.9
	0.975	10.0		7.0	7.8	6.0	6.6	5.4	5.9	5.0	5.5
	0.95	11.0		7.9	8.7	6.7	7.3	6.0	6.6	5.6	6.1
	0.90	12.0	13.0	8.8	9.6	7.4	8.0	6.7	7.2	6.2	6.6
	0.85	14.0		9.7	10.5	8.1	8.9	7.3	7.9	6.7	7.2
No. 4 Sieve	1.00	0.0	9.0	0.0	6.7	0.0	5.7	0.0	5.2	0.0	4.8
	0.975	10.0		6.8	7.6	5.8	6.3	5.3	5.8	4.9	5.4
	0.95	11.0		7.7	8.5	6.4	6.9	5.9	6.4	5.5	5.9
	0.90	12.0	13.0	8.6	9.4	7.0	7.5	6.5	7.0	6.0	6.5
	0.85	14.0		9.5	10.2	7.6	8.0	7.1	7.6	6.6	7.0
No. 8 Sieve	1.00	0.0	7.0	0.0	5.6	0.0	4.8	0.0	4.3	0.0	4.0
	0.975	8.0		5.7	6.3	4.9	5.4	4.4	4.8	4.1	4.5
	0.95	9.0		6.4	7.0	5.5	6.0	4.9	5.3	4.6	4.9
	0.90	10.0		7.1	7.7	6.1	6.6	5.4	5.8	5.0	5.4
	0.85	11.0	12.0	7.8	8.5	6.7	7.2	5.9	6.4	5.5	5.8
No. 16 Sieve	1.00	0.0	7.0	0.0	5.2	0.0	4.6	0.0	4.2	0.0	3.9
	0.975	8.0		5.3	5.8	4.7	5.1	4.3	4.6	4.0	4.3
	0.95	9.0		5.9	6.4	5.2	5.6	4.7	5.1	4.4	4.7
	0.90	10.0		6.5	7.0	5.7	6.1	5.2	5.5	4.8	5.1
	0.85	11.0	12.0	7.1	7.6	6.2	6.6	5.6	5.9	5.2	5.4
No. 50 Sieve	1.00	0.0	6.0	0.0	4.3	0.0	3.8	0.0	3.4	0.0	3.2
	0.975	7.0		4.4	4.8	3.9	4.1	3.5	3.8	3.3	3.5
	0.95	8.0		4.9	5.3	4.2	4.5	3.9	4.1	3.6	3.8
	0.90	9.0		5.4	5.8	4.6	4.9	4.2	4.4	3.9	4.1
	0.85	10.0		5.9	6.4	5.0	5.5	4.5	4.9	4.2	4.5

TABLE B - NON-COMPLYING COMPACTION TESTS

TEST METHOD	PAY FACTOR	PERCENT OF BULK DENSITY TARGET	
		Mean of all Tests	Lowest of all Tests
ASTM D 3203			
	1.00	95 to 100	92 or greater
	0.90	95 to 100	Less than 92
	0.50	Less than 95	92 or greater

TABLE C - THICKNESS DEFICIENCY

PAY FACTOR	AVERAGE CORE THICKNESS DEFICIENCY (in inches)
100	0.00 - 0.25
90	0.26 - 0.50
80	0.51 - 0.75
50	0.76 - 1.00
Remove and Replace	More than 1.00

02512.5.3 REMOVAL OF MIX

The Engineer may order the removal of the mix if the mean result of the lot acceptance tests deviate from the required percentage for a particular sieve or sieves, or if the asphalt content differs more than the values shown under the 0.85 pay factor in Table A. Where material not meeting these criteria is allowed to remain, a pay factor of 0.50 will be applied.

When the tested density percentage pay factor in Table B is multiplied by the pay factor shown in Table A, and the product is less than 0.80, the Engineer may order removal of the mix. Where material not meeting this criteria is allowed to remain, a pay factor of 0.50 will be applied.

02512.5.4 ADDITIONAL MIX

When a lot shows a deficient thickness of more than 0.5-inches, the Engineer may order additional material to be placed and additional payment for that material will be allowed. When excess thickness is determined, the Engineer may allow it to remain in place; however, only 50 percent of the mix in excess of the 0.5-inch tolerance will be paid for.

02512.5.5 OPTIMAL ASPHALT CONTENT PERCENTAGE

Optimal asphalt content percentage will be determined from the information provided herein and/or on the Drawings.

02513.1 DESCRIPTION

This section covers preparing an existing bituminous or concrete surface and then furnishing and applying an asphalt coating to it.

02513.1.1 RELATED WORK

Section 02511 - Hot Plant Mix Bituminous Pavement
Section 02512 - Road Mix Bituminous Pavement

02513.1.2 SUBMITTALS

The Contractor shall provide certificates from the paving asphalt vendor indicating the type and grade of material being provided and its compliance with the standards indicated herein.

02513.1.3 DEFINITIONS

Not used.

02513.2 MATERIALS

The asphalt coating shall meet the current requirements contained in the "Standard Specifications for Paving and Industrial Asphalts" issued by the Asphalt Institute, for the type and grade of asphalt shown on the Drawings or in these Specifications. When the asphalt type and grade are not shown on the Drawings or in these Specifications, SS-1 or SS-1h emulsified asphalt diluted with not more than one part water to one part emulsified asphalt will be acceptable.

02513.3 CONSTRUCTION**02513.3.1 WEATHER LIMITATIONS**

Tack coats shall be applied only when air and roadbed temperatures in the shade are greater than 50° F. Application of tack coats shall not be made during rain, fog, dust, or other unsuitable weather.

02513.3.2 PREPARATION

Prior to application of the tack coat, the receiving surface shall be broomed to remove dust and loose foreign materials. The Contractor shall provide notice of application to adjacent property owners 24 hours prior to applying the coating. Appropriate measures shall be taken to provide crossings for foot or vehicular traffic to minimize tracking of freshly applied tack coating.

If flushing of the surface with water is necessary for removal of dust and foreign material, the Engineer may require flushing. When flushing is ordered, the Contractor will be authorized compensation for flushing by issuance of a Change Order.

02513.3.3 APPLICATION

Limit application of tack coats to areas which can be covered with an asphalt pavement layer that same day when possible.

Application of the coating shall be accomplished with a distributor designed, equipped, maintained and operated so that bituminous material will be applied at an even temperature and uniform rate on variable widths of surface up to 16-feet. The distributor must be capable of controlling rates of

application from 0.05 to 2.0 gallons per square yard, with uniform pressure and with a variation from the rate set not to exceed 0.02 gallon per square yard. Operable measuring equipment shall be included on the distributor which includes a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperature of the bituminous in the tank. Distributors shall be equipped with (1) a power unit for the pump; (2) full circulation spray bars that adjust laterally and vertically; and (3) a hose and nozzle attachment for applying material to areas inaccessible to the distributor spray bar.

Spray rates for the coating shall be as required by the Drawings or these Specifications. When no rate is specified otherwise, the Engineer may require an application rate for emulsions of 0.05 to 0.15 gallons per square yard.

02513.3.4 PROTECTION

Protect adjacent structures,(curbing, sidewalks, guardrails, sign posts, etc.) from being spattered or marred by covering with suitable materials. The expense of removal of such spattering shall be born by the Contractor.

Traffic shall not be allowed to travel over the freshly applied coating until it has cured sufficiently to not be picked up by traffic.

02513.4 METHOD OF MEASUREMENT

Measurement of Asphalt Tack Coat shall be by the ton or gallon for the type and grade of material furnished and applied.

02513.5 BASIS OF PAYMENT

The accepted quantity will be paid for at the contract unit cost for:

PAY ITEM	UNIT
Asphalt Tack Coat (<i>Type/Grade</i>)	Ton
Asphalt Tack Coat (<i>Type/Grade</i>)	Gallon

02514.1 DESCRIPTION

This work includes furnishing and applying a liquid asphalt coating and blotter material (when requested) to a prepared surface. The surface to be coated shall be approved in writing prior to application of the coating.

02514.1.1 RELATED WORK

Section 02511 - Hot Plant Mix Bituminous Pavement
Section 02512 - Road Mix Bituminous Pavement

02514.1.2 SUBMITTALS

The Contractor shall provide certificates from the paving asphalt vendor indicating the type and grade of material being provided and its compliance with the standards indicated herein.

02514.1.3 DEFINITIONS

Not used.

02514.2 MATERIALS

02514.2.1 The asphalt coating shall meet the current requirements contained in the "Standard Specifications for Paving and Industrial Asphalts" issued by the Asphalt Institute, for the type and grade of asphalt shown on the Drawings or in these Specifications. When the asphalt type and grade is not shown on the Drawings or in these Specifications, MC-70 or MC-250 liquid asphalt will be acceptable.

02514.2.2 Blotter material shall be graded granular sand material which passes the No 4 sieve and does not contain more than four percent of fine particles which pass the No. 200 sieve.

02514.3 CONSTRUCTION**02514.3.1 WEATHER LIMITATIONS**

Prime coats shall be applied only when air and roadbed temperatures in the shade are greater than 55 degrees F. Application of prime coats shall not be made during rain, fog, dust, or other unsuitable weather.

02514.3.2 PREPARATION

The surface to be treated with prime coating shall be lightly bladed and rolled with a smooth-wheel roller immediately before application of the asphalt coating.

02514.3.3 APPLICATION

Limit application of prime coats to areas which can be covered with an asphalt pavement layer that same day when possible.

Application of the coating shall be accomplished with a distributor designed, equipped, maintained and operated so that bituminous material will be applied at an even temperature and uniform rate on variable widths of surface up to 16-feet. The distributor must be capable of controlling rates of application from 0.05 to 2.0 gallons per square yard, with uniform pressure and with a variation from the rate set not to exceed 0.02 gallon per square yard. Operable measuring equipment shall

be included on the distributor which includes a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperature of the bituminous in the tank. Distributors shall be equipped with (1) a power unit for the pump; (2) full circulation spray bars that adjust laterally and vertically; and (3) a hose and nozzle attachment for applying material to areas inaccessible to the distributor spray bar.

Spray rates for the coating shall be as required by the Drawings or these Specifications. When no rate is specified otherwise, the Engineer may require an application rate for emulsions of 0.05 to 0.15 gallons per square yard.

02514.3.4 PROTECTION

Protect adjacent structures (curbing, sidewalks, guardrails, sign posts, etc.) from being spattered or marred by covering with suitable materials. The expense of removal of such spattering shall be born by the Contractor.

Traffic shall not be allowed to travel over the freshly applied coating until it has cured sufficiently to not be picked up by traffic.

Blotter material shall be spread to cover any unabsorbed bituminous material if traffic must be routed over the primed surface before the prime coating has dried sufficiently to prevent pickup by vehicles or to minimize damage by rain

02514.4 METHOD OF MEASUREMENT

Measurement of Asphalt Prime Coat shall be by the ton or gallon for the type and grade of material furnished and applied.

02514.5 BASIS OF PAYMENT

The accepted quantity will be paid for at the contract unit cost for:

PAY ITEM	UNIT
Asphalt Prime Coat (<i>Type/Grade</i>)	Ton
Asphalt Prime Coat (<i>Type/Grade</i>)	Gallon

02515.1 DESCRIPTION

This section covers preparing an existing bituminous surface and then furnishing and applying an asphalt coating, followed with an application of cover aggregate when required.

02515.1.1 RELATED WORK

Not used.

02515.1.2 SUBMITTALS

The Contractor shall provide certificates from the paving asphalt vendor indicating the type and grade of material being provided and its compliance with the standards indicated herein.

02515.1.3 DEFINITIONS

Not used.

02515.2 MATERIALS

02515.2.1 ASPHALT COATING

The asphalt coating shall meet the current requirements contained in the “Standard Specifications for Paving and Industrial Asphalts” issued by the Asphalt Institute, for the type and grade of asphalt shown on the Drawings or in these Specifications. When the asphalt type and grade is not shown on the Drawings or in these Specifications, LM CRS-2A emulsified asphalt diluted with not more than one part water to one part emulsified asphalt will be acceptable.

02515.2.2 COVER AGGREGATE

Cover aggregates shall be crushed slag or natural aggregates which meet requirements for quality and gradation shown below in Table S-1, unless shown otherwise in the Special Provisions.

TABLE S-1 - COVER AGGREGATE QUALITY AND GRADATION REQUIREMENTS

Characteristic/Sieve Size	AASHTO Test Method	Requirement
Quality		
Wear	T-96	40% maximum
Stripping	T-182	95% maximum (coated**)
Durability Index	T-210	35% minimum
One mechanically fractured face to material retained on No. 8 Sieve.		50% minimum
Gradation		
½-inch	T-11	100% passing
3/8-inch	T-11	70 100 % passing
No. 4	T-11	0-20% passing
No. 8	T-11	0-5% passing
No. 200	T-11	0-2% passing

** An approved chemical additive may be used to meet this requirement.

The aggregate shall be clean and contain less than 2 percent moisture based on dry weight.

02515.3 CONSTRUCTION

02515.3.1 WEATHER LIMITATIONS

With the exception of the States of Arizona and Nevada and other areas indicated in the Contract Documents, seal coats shall be applied between May 15 and August 31 and only when air and roadbed temperatures in the shade are greater than 65 degrees F. Application of seal coats shall not be made during rain, fog, dust, or other unsuitable weather. Written approval must be obtained from the Engineer to apply the seal coating at any other time or condition.

02515.3.2 PREPARATION

02515.3.2.1 CLEANING - Within four hours prior to application of the asphalt coat, the receiving surface shall be broomed to remove dust and loose foreign materials. The Contractor shall provide notice of application to adjacent property owners not less than 24 hours prior to applying the coating. Appropriate measures shall be taken to provide control of foot or vehicular traffic to protect and minimize tracking of the freshly applied seal coating.

02515.3.2.2 FLUSHING - If flushing of the surface with water is necessary for removal of dust and foreign material, the Engineer may require flushing. When flushing is ordered, the Contractor will be authorized compensation for flushing by issuance of a Change Order.

02515.3.3 APPLICATION

02515.3.3.1 ASPHALT DISTRIBUTOR - Application of the asphalt material shall be accomplished with a distributor designed, equipped, maintained and operated so that bituminous material will be applied at an even temperature and uniform rate on variable widths of surface up to 12-feet. The distributor must be capable of controlling rates of application from 0.05 to 2.0 gallons per square yard, with uniform pressure and with a variation from the rate set not to exceed 0.02 gallon per square yard. Operable measuring equipment shall be included on the distributor which includes a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperature of the bitumen in the tank. Distributors shall be equipped with (1) a power unit for the pump; (2) full circulation spray bars that adjust laterally and vertically; and (3) a hose and nozzle attachment for applying material to areas inaccessible to the distributor spray bar.

The distributor shall be moving forward at the proper application speed when the spray bar is actuated. Junctions of spreads shall be carefully joined, without overlap, to ensure smooth surface results after the seal coating is applied. Transverse joints shall be made by using building paper to mask off previous adjoining seal coatings. Upon completion of a joint, the building paper and coating material shall be removed and disposed in a manner consistent with local waste disposal requirements.

Spray rates for the coating shall be as required by the Drawings or these Specifications. When no rate is specified otherwise, the Engineer may require an application rate of 0.35 to 0.40 gallons per square yard.

02515.3.3.2 AGGREGATE SPREADING - The aggregate spreader shall be specifically designed for uniformly depositing aggregate over a surface at variable controlled rates. Spreading of aggregate directly from a dump truck will not be approved. Spreading of aggregate on areas inaccessible to spreading equipment will be accomplished by hand spreading with shovels and rakes and then rolled with hand-operated rollers or compactors sufficiently to embed the aggregate.

Spreading operations shall proceed in such a manner that the aggregate contacts the bituminous material before it chills, sets up, dries, or other conditions occur that may impair adhesion of the aggregate to the asphalt. The aggregate spreader shall be operated so that it is not more than 100-feet behind the asphalt distributor and so that the bituminous material will be covered with aggregate before any traffic passes over it. Spread rate will be 2 lbs. Per square yard.

Any piles or ridges of aggregate materials resulting from uneven distribution shall be removed before any rolling over the area. Initial rolling shall consist of one pass with a pneumatic-tire roller in a longitudinal direction. The amount of rolling shall be sufficient to uniformly bond the aggregate over the full width, and in no case shall be less than three complete coverages.

02515.3.4 **PROTECTION**

02515.3.4.1 **ADJACENT STRUCTURES** - Adjacent structures, (curbing, sidewalks, guardrails, sign posts, etc.) shall be protected from being spattered or marred with sprayed asphalt by covering with suitable materials. The removal of resulting spattering shall be made at the expense of the Contractor.

02515.3.4.2 **TRAFFIC** - Controlled traffic shall not be allowed to travel over the freshly applied coating for 4 hours after it has been rolled and cured sufficiently to not be picked up by traffic. The finished surface shall be swept to remove loose aggregate particles before allowing uncontrolled traffic on it.

02515.4 METHOD OF MEASUREMENT

02515.4.1 **ASPHALT COATING**

Measurement of Asphalt Coating shall be made by counting the number of tons, or gallons, of each type and grade of material furnished and applied.

02515.4.2 **Cover Aggregate** shall be measured by counting the number of tons of material furnished and spread.

02515.5 BASIS OF PAYMENT

The accepted quantity will be paid for at the contract unit cost for:

PAY ITEM	UNIT
Asphalt Seal Coat (<i>Type/Grade</i>)	Ton
Asphalt Seal Coat (<i>Type/Grade</i>)	Gallon
Cover Aggregate	Ton

02520.1 DESCRIPTION

This section covers cutting through designated sections of bituminous and/or concrete pavement surface with approved equipment in preparation for pavement removal.

02520.1.1 RELATED WORK

Section 02200 - Trench Excavation and Backfill
Section 02208 - Flowable Backfill (required during winter months)
Section 02500 - Removal and Replacement of Surface Improvements

02520.1.2 SUBMITTALS

Not used.

02520.1.3 DEFINITIONS

Not used.

02520.2 MATERIALS

Not used

02520.3 CONSTRUCTION REQUIREMENTS**02520.3.1 SAW CUTTING**

02520.3.1.1 NEATNESS IN CUTTING - Pavement cuts shall be made with a saw to produce straight vertical cuts through the full depth of the surfacing layer. The Contractor is responsible to preserve and maintain a neat clean edge on the cut pavement to facilitate pavement repair or replacement under Section 02500.

02520.3.1.2 CUT MATERIALS TO BE LEFT IN PLACE - Cut pavement materials shall be left in place. Removal of cut pavement will be included as part of other work items in this Contract.

02520.3.1.3 BROKEN PAVEMENT - When pavement has deteriorated or is severely cracked and broken, the Contractor shall discontinue cutting operations and obtain direction from the Engineer as to how cutting should proceed.

If pavement is broken after sawcutting and prior to replacement, the Contractor shall re-cut the pavement. Such re-cutting shall not be measured for payment.

02520.3.2 WHEEL CUTTING

With advanced written approval of the Engineer, wheel cutting may be substituted for saw cutting of bituminous pavement surface. Wheel cutting operations shall be subject to the same requirements as those for saw cutting pavement above.

02520.3.3 ROTOMILLING

Rotomilling of existing pavement is an acceptable alternative to saw cutting, providing that the resulting pavement edges are left clean and neat. Rotomilled material may be suitable for trench backfilling or as a substitute for road base. For such use, rotomilled material must meet the following conditions: that: no chunks or pieces larger than one inch in any dimension are used, that

it is placed in separate lifts from untreated base course, that it is compacted to 95% of its maximum density, and that it is acceptable to the Engineer and to the Owner.

02520.4 METHOD OF MEASUREMENT

Measurement for pavement cutting shall be made using a tape measure or other accurate measuring device to determine the number of lineal feet of pavement cut. This length shall be multiplied by the actual depth of the cut pavement layer, measured in inches, to give the number of inch feet of cut.

An alternative method of measurement is for the Engineer to determine that all pavement cutting shall be paid for by the measured lineal feet without regard to depth.

02520.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
Pavement Sawing	Inch/Foot
Pavement Sawing	Lineal Feet

02810.1 DESCRIPTION

This section covers furnishing and installing chain link fence and gates as indicated on the Drawings

02810.1.1 RELATED WORK

Section 03050 - Portland Cement Concrete

02810.1.2 SUBMITTALS

Not used.

02810.1.3 DEFINITIONS

Not used.

02810.2 MATERIALS

02810.2.1 FENCING FABRIC, SUPPORT, AND CONNECTORS

02810.2.1.1 FABRIC - Fence fabric shall be in accordance with ASTM A-392 and have the following characteristics:

FENCE FABRIC CHARACTERISTICS

Height	6'-0"
Mesh	2 inch, coated
Size Wire	11 gauge
Coating	Zinc (galvanized)

02810.2.1.2 TOP RAIL - Top rail shall be 1 5/8 inch OD, galvanized steel pipe @ 1.82 lbs./ft., or fence tube of equivalent structure, size and strength.

02810.2.1.3 WIRE RING TIES - Use wire ring ties that carry a Class II coating and are 11-gauge wire in accordance with ASTM A-116.

02810.2.1.4 BARBED WIRE - Barbed wire for extension arms shall have the following characteristics:

BARBED WIRE CHARACTERISTICS

Total Number Strands	3 strands barb wire
Wires per Strand	2
Wire Size	12 gauge (minimum)
Barbs	14 gauge, 4 point @ 4" o.c.
Coating	Zinc (galvanized)

02810.2.1.5 TENSION WIRE - Tension wire shall be 7 gauge galvanized coil spring steel wire in accordance with ASTM A-641.

02810.2.1.6 TRUSS RODS - Truss rods shall be 3/8 inch galvanized steel rod.

02810.2.1.7 **EXTENSION ARMS** - Extension arms for gate and other fence posts shall be fabricated from galvanized steel. They shall be designed and manufactured to carry three separate strands of barbed wire and shall be capable of supporting a 200-pound vertical load at the end of the arm without causing permanent deflection. Gateposts shall be provided with vertical extension arms while all other post shall have 45° angle extension arms. The top rail shall pass through the extension arm fitting.

02810.2.2 **POSTS**

All pipe posts shall be provided with tops that shed water. All posts, rails, and appurtenances shall be provided in accordance with ASTM A-120, A-121, A-123 or A-153, respectively.

02810.2.2.1 **LINE POSTS** - Line posts shall be "H" section at 4.10 pounds per lineal foot, or 2-3/8 inch OD galvanized pipe at 3.12 pounds per lineal foot, or fence tube of equivalent size and strength.

02810.2.2.2 **END, CORNER, AND PULL POSTS** - End, corner and pull posts shall be 2-7/8 inch OD pipe at 4.64 pounds per lineal foot, galvanized pipe or fence tube of equivalent size and strength.

02810.2.2.3 **GATEPOSTS** - Except where shown otherwise in the Contract Documents, gateposts shall be provided in accordance with the table below. Gateposts shall be Schedule 40 galvanized steel pipe of the diameter and weight shown. Fence tube of equivalent size and strength may be substituted for the galvanized steel pipe specified herein.

GATEPOST SPECIFICATIONS

Leaf Width	Gate Post OD	Lbs per Lineal Ft	Concrete Foundation	
			Diameter	Depth
0' – 6'	2-7/8"	5.7	12"	3'-0"
Over 6' to 13'	4"	9.0	18"	4'-0"
Over 13' to 18'	6-5/8"	18.9	18"	4'-0"
Over 18'	8-5/8"	28.5	18"	4'-6"

02810.2.3 **GATES**

02810.2.3.1 **TYPE AND SIZE** - Swing gates of the type and size shown on the Drawings shall be used for all chain link fence gates.

02810.2.3.2 **FRAME** - Gate frame piping shall be 1 7/8 inch OD galvanized pipe weighing 2.68 pounds per lineal foot. Corner fittings shall be heavy pressed steel or malleable castings.

02810.2.3.3 **CATCH AND LOCK** - Gates shall be provided with an appropriate steel or malleable iron catch and locking attachment. Double swing gates shall be provided with a center rest and catch mechanism. Stops shall be provided to hold gates open.

02810.2.3.4 **FABRIC** - Chain link fence fabric used to cover gate frames shall conform to the same standards as the line fence fabric.

02810.2.4 CONCRETE

Concrete for setting posts and other fencing components for chain link fence and gates shall be Class 2000 or higher with 3/4 inch maximum aggregate in accordance with Section 03050 of these Specifications.

02810.3 CONSTRUCTION REQUIREMENTS

02810.3.1 GENERAL

Finished fence shall be plumb, taut, true to line and grade, and complete in all details. Fence shall be installed with a top rail and a bottom tension wire. Top rail shall provide allowance for expansion and contraction due to temperature differential in the coupling devices. The ground shall be graded before fence posts are located to permit the grade of the fence to remain uniform over any local elevations or depressions in the ground line. Any resultant surplus soil or concrete, etc., shall be removed and the line shall be cleaned up prior to completion of the Work.

02810.3.2 POSTS

02810.3.2.1 BRACING - End, corner, pull, slope and gateposts shall be braced to the midpoint of the nearest line post or posts with horizontal braces used as compression members. The bracing material shall be the same as top rail material. The brace posts shall be trussed from the brace back to the bottom of the end, corner, slope or gatepost with steel truss rods with turnbuckles, or other suitable tightening devices used as tension members.

2810.3.2.2 LINE POST PLACEMENT - Line posts shall be placed in accordance with the following spacing requirements:

LINE POST PLACEMENT

Radius of Curve	Maximum Post Spacing
Tangent Section to 500 ft	10 ft.
200 ft. to 499 ft.	8 ft.
100 ft. to 199 ft.	6 ft.
0 ft. to 99 ft	5 ft.

02810.3.2.3 PULL POST PLACEMENT - Pull posts shall be located at 500-foot maximum intervals and/or at all angle points exceeding 20°.

02810.3.3 CONCRETE

02810.3.3.1 DEPTH OF SET - Post sockets in concrete walls shall be set to a minimum depth of 18 inches. Line posts shall be set in concrete to a minimum depth of 18 inches. End, pull, corner and gateposts less than 6 inches in diameter shall be set in concrete to a minimum depth of 24 inches. Gateposts 6 inches diameter and greater shall be set in concrete to a depth of 30 inches

A minimum of 6 inches concrete shall be placed in each posthole below each post depth of set described in the foregoing paragraph.

02810.3.3.2 FINISH - Concrete for fence posts shall be finished with a minimum of 1 inch of concrete left above finish grade and sloped in all directions to allow water to drain away from the post.

02810.3.4 FENCE FABRIC

02810.3.4.1 PLACEMENT - Fence fabric shall be installed on the outward facing side of the posts and parallel to the line of the fabric. It shall be 1 inch above the ground on straight grade with the top edge projecting over the top rail of the fence. Space between the bottom of the fence and the finished ground line shall not exceed 3 inches.

02810.3.4.2 FASTENING - Fence fabric shall be stretched taut and securely fastened to the posts, the top rail and the bottom tension wire. Install the tension wire.

Fabric shall be attached to line posts every 14 inches with 11 gauge hot dip galvanized wire clips or galvanized steel bands. It shall be attached to terminal, corner, and gateposts every 14 inches by using 1/4" x 3/4" tension bars tied to the posts with 1 inch wide, hot-dip galvanized steel bands and 3/8 inch diameter bolts and nuts. Attach to both the top rail and the tension wire with 11 gauge wire ring ties spaced every 24 inches.

02810.3.5 CHAIN LINK GATE

02810.3.5.1 INSTALLATION - Chain link gates of size and type shown on the Drawings shall be installed plumb, level and secure for full opening without interference. The gates shall be installed at the locations shown, unless approved otherwise by the Engineer. Ground items shall be set in concrete for anchorage as recommended by fence manufacturer.

The corners of gate frames shall be fastened together and reinforced with fittings designed for the purpose or by welding. All welds shall be ground smooth.

02810.3.5.2 FABRIC - Chain link fence fabric shall be attached to gate frames with tension bars and tie wire attached to suitable tension connectors spaced at approximately 15 inches at each end, and to the top and bottom rails with tie wires spaced at approximately 24 inches.

02810.4 METHOD OF MEASUREMENT

Measurement for chain link fence shall be made using a tape measure or other accurate measuring device to determine the number of lineal feet of fence installed and accepted. This measurement shall include all work and materials, excavation, concrete and concrete placement, gates and bends, etc., all to be furnished and installed as shown on the Drawings and described herein.

02810.5 BASIS OF PAYMENT

PAY ITEM	UNIT
Chain Link Fence	Lineal Foot

02830.1 DESCRIPTION

This section covers furnishing and installing stock fencing and gates as indicated herein and as shown on the Drawings.

Use stock fence and gates as right-of-way fence and gates.

02830.1.1 RELATED WORK

Section 03300 – Concrete Structures and Slabwork

02830.1.2 SUBMITTALS

Not used.

02830.1.3 DEFINITIONS

Not used.

02830.2 MATERIALS

02830.2.1 FENCE MATERIALS

02830.2.1.1 BARBED WIRE - Barbed wire for fencing shall meet the following standards:

BARBED WIRE REQUIREMENTS

Total Number Strands	As called for on Drawings
Wires per Strand	2
Wire Size	12 gauge (minimum)
Barbs	14 gauge, 4 point @ 4" o.c.
Coating	Zinc (galvanized)

02830.2.1.2 WIRE MESH FABRIC - Wire mesh fabric for fencing shall meet the following standards.

WIRE MESH FABRIC REQUIREMENTS

Wire Grade	Firm
Wire Size	Nominal 0.099
Vertical Spacing	6 inches
Coating	Class 1 Zinc
Fabric Specification	ASTM A-116

02830.2.2 POSTS

02830.2.2.1 STEEL LINE POSTS - Steel line posts shall have either a Y or U cross-section, shall be painted, and shall have been manufactured for use in stock fencing.

02830.2.2.2 WOOD LINE POSTS - All posts must be sound and free of decay, being structurally fit to function properly. Wood line posts shall meet the following requirements:

- Round posts shall have a minimum circumference of 10 inches at the base. All natural-growth round posts shall be free of bark, protruding knots, and any other irregularities.

- Rectangular posts shall have a minimum cross section area of 12 square inches.
- Untreated posts shall be of un-sawn native juniper, or approved equal.
- Treated line posts shall be of Douglas Fir, hemlock or pine. If the treated surface of a post has been disturbed or damaged in handling or installation, the exposed, untreated wood shall receive a minimum of two coats of the same compound with which the post was originally treated.

02830.2.2.3 BRACE, GATE, AND CORNER POSTS – Brace, gate, and corner posts shall conform to ASTM A-702. Steel brace, gate, and corner posts shall have the following characteristics:

02830.2.2.4 GALVANIZED PARTS - Galvanized parts shall be in accordance with ASTM A-123.

02830.2.2.5 ANCHORS - Supply fence stop anchors. Anchor plates on steel posts may be omitted when the post is set in a concrete footing but not otherwise.

02830.2.3 STEEL GATES

02830.2.3.2 FRAME – Frames for driveway and walkway gates shall be of 1-inch diameter pipe as specified in ASTM A-120, Schedule 40. Frames shall have caps or seals to cover the open ends of square corners of gate frames.

02830.2.3.3 WIRE FABRIC – See 02830.2.1.2 above.

02830.2.3.4 BRACING – 10 and 12 foot long gate leafs shall have at least one vertical brace made of the same material as the frame and placed in the center of the leaf. 14 and 14 foot long gate leafs shall have two vertical braces of the same material and spaced evenly in the leaf.

02830.2.3.5 TRUSSING – Gates 10 feet or more in length shall have an adjustable 3/8-inch minimum diameter truss rod installed to prevent sagging of the gate.

02830.2.3.6 FITTINGS - Fittings for gates shall be hot-dipped galvanized steel as specified in accordance with ASTM A-153. Pintles shall be 5/8-inch in diameter or greater for 10-foot and wider gates.

02830.2.3.7 FASTENERS – Fasteners for single gates shall be lengths of galvanized chain a minimum of 18-inches long. One end of the chain shall be secured to the gate while the loose end shall be fitted with a snap fastener appropriate to the size of the chain. For additional security, chain link slot fasteners also may be incorporated into the gate.

Double leaf driveway gates shall have a center latch incorporating a pin or rod which can be dropped from the latch into a socket embedded in concrete in the ground.

02830.2.3.8 STAPLES – Staples shall be 1-1/2-inch minimum length No. 9 wire.

02830.2.3.9 CONCRETE – Concrete shall be Class B (AE) or better.

02830.3 CONSTRUCTION REQUIREMENTS

02830.3.1 GENERAL

Finished fence shall be plumb, taut, securely fastened, true to line and grade, and complete in all details.

02830.3.2 POST INSTALLATION

02830.3.2.1 GATEPOSTS - Except where shown differently on the plans, gatepost installation and concrete foundations for gateposts shall be as determined by the following schedule:

GATEPOST SPECIFICATIONS

Leaf Width	Gate Post OD	Lbs per Ln. Ft.	Concrete Foundation	
			Diameter	Depth
0' – 6'	2-7/8"	5.7	12"	3'-0"
Over 6' to 13'	4"	9.0	18"	4'-0"
Over 13' to 18'	6-5/8"	18.9	18"	4'-0"
Over 18'	8-5/8"	28.5	18"	4'-6"

02830.3.2.2 STEEL LINE POSTS - Construction of 4-strand barbed wire fencing shall require 6-foot posts; 5-strand barbed wire fencing shall use 7-foot posts.

02830.3.2.3 WOOD POSTS - Cut wood posts to the designated height and slant top to an approximate 30° angle.

02830.3.2.4 POST BRACING - Install end-braced posts in existing cross fences where they are intersected by the new stock fence. Brace corner posts in two directions. Brace end and gate posts in one direction. Bolt or butt weld metal braces to the metal posts. Tension brace wires until installation is rigid.

02830.3.2.5 TRUSSING - Braced posts shall be trussed back to the bottom of the end, corner, slope or gatepost.

02830.3.2.6 CONCRETE - At sag sections, or at points of vertical alignment change in concrete foundations, set braced posts at least 2-feet 9-inches into the ground for 7-foot, 0-inch posts and at least 2-feet 6-inches into the ground for 6-foot, 0-inch posts. Place a minimum 3-inch concrete base below each brace post. Concrete shall be a minimum 18-inches in diameter. Expose 1-inch on concrete above the finished grade, finish off and slope to drain away from the post. Backfill and compact posts.

Set fence stop anchors in concrete foundations at least 18-inches into the ground. Concrete shall be a minimum of 18-inches in diameter. Finish exposed concrete flush with existing grade.

02830.3.3 FENCE WORK

02830.3.3.1 BARBED WIRE - Barbed wire fencing shall be constructed of either 4-strands or 5-strands of wire as shown on the Drawings and/or described in the Special Provisions attached hereto. See also Sub-Section 02830.3.2.2 – Steel Line Posts, above. Install barbed wire on the inside of the post, away from the traffic.

02830.3.3.2 FABRIC - Wire mesh fabric shall be of the width shown on the Drawings and/or described in the Special Provisions attached hereto. Install fence fabric and barbed wire on the inside of the post, away from the roadway.

Remove all sags from wire mesh fabric without causing tension crimps to fail. Staple top and bottom wires and every alternate lateral wire in the mesh fabric and each strand of barbed wire to the post.

02830.3.4 STEEL GATES

02830.3.4.1 GATES - Supply steel gate frames with wire fabric and appropriate appurtenances for all gates shown on the Drawings.

02830.3.4.2 INSTALLATION - Provide steel gates with fittings to fill all clear openings between gateposts as shown on the Drawings. Install gates to open clearly without interference and to function properly.

02830.4 METHOD OF MEASUREMENT

Measurement for stock fence and gates shall be made using a tape measure or other accurate measuring device to determine the total number of lineal feet of fence installed and accepted. This measurement shall include all material, equipment, labor, excavation and backfill, gates, bends, concrete and concrete placement including gates and bends, all to be furnished and installed as shown on the Drawings and described herein.

02830.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
Stock Fence	Lineal Foot

02890.1 DESCRIPTION

This work shall consist of installing only, or furnishing and installing delineators, signs, sign supports, panels and posts or removing and disposing of existing signs, posts and hardware.

02890.1.1 RELATED WORK

Section 02005 – Traffic Control

02890.1.2 SUBMITTALS

Not used.

02890.1.3 DEFINITIONS

Not used.

02890.2 MATERIALS

02890.2.1 TRAFFIC CONTROL SIGNS

Traffic control sign details not shown on the Drawings shall meet the requirements of the Manual of Uniform Traffic Control Devices issued by the U.S. Department of Transportation. Requirements for temporary signs used for traffic control during construction are provided in Section 02005 of these Specifications.

02890.2.1.1 SIGN PANELS

02890.2.1.2 PANELS – All panels shall be of one-piece construction made from plywood, sheet steel or sheet aluminum, as shown in the Schedule of Items. All panels shall have the face side reflectorized.

02890.2.1.3 PLYWOOD PANELS – Plywood panels shall be exterior Type B-B, high-density overlay, 60/60 with black overlay on both sides, 3/4-inch 7 ply or 1/2-inch 5 ply thick, Douglas fir plywood or better, meeting the requirements of the National Bureau of Standards PS-1, current edition or as shown on the Drawings. Other overlay colors may be used provided the back of the panel is printed with two heavy coats of black paint.

Paint used shall be ready-mixed, exterior type, polysilicone alkyd resin base enamel, Benjamin Moore No. 120-60 (Federal Color Chip No. 20059), or approved equal.

02890.2.1.4 ALUMINUM PANELS - All aluminum sheet or plate used for panels shall meet the requirements of ASTM B-209, alloy 6061-T6 or 5052-H38 and shall be of the thickness prescribed below, unless otherwise shown on the Drawings.

SHEET ALUMINUM REQUIREMENTS

Sign Width (Inches)	Sheet Aluminum Thickness (Inches)
Less than 8	0.022
8-12	0.040
13-19	0.063
20-30	0.080
31-48	0.100
over 48	0.125

- 02890.2.1.5 **STEEL PANELS** - The finished plate for steel panels shall be free of twist or buckle, and the background shall be substantially a plane surface. The finished sign panel shall be of continuous coat mill-galvanized phosphate coated steel.
- 02890.2.2 **SIGN POSTS**
- 02890.2.2.1 **POSTS** - Posts shall be wood, aluminum, steel or other material as specified.
- 02890.2.2.2 **WOOD POSTS** - Wood posts shall be construction grade or better Douglas Fir or graded pine, and shall conform to the grading and dressing rules of the Western Wood Products Association. Wood posts shall cut to size before treatment and shall be of the dimensions shown on the Drawings. Unless otherwise specified, posts shall be incised before treatment as a means of improving penetration of the preservative. Wood posts shall be pressure treated in accordance with AASHTO M-133 and/or the Uniform Building Code for Posts and also in compliance with the standards of the American Wood Preservers Association.
- 02890.2.2.3 **STEEL POSTS.** Steel posts shall meet the requirements of ASTM A-299, galvanized in accordance with AASHTO M-111. Minimum weight per foot will be as shown on the Drawings.
- The posts shall have 7/16-inch holes drilled or punched, before galvanizing, along the centerline of the web. The punching or drilling should begin 1-inch from the top of the post, at 2-inch centers for the upper 5-feet of the post.
- 02890.2.2.4 **ALUMINUM POSTS** - Aluminum posts shall be standard shapes as shown on the Drawings and shall be aluminum alloy 6061-T6 or 6351-T5, meeting the requirements of ASTM B-221.
- 02890.2.3 **FITTINGS**
- Lag screws, washers, clip angles, wood screws, shear plates, U-bolts, clamps, bolts, nuts and other fasteners shall be galvanized steel, cadmium-plated steel, aluminum alloy or as shown on the Drawings. Galvanizing of steel hardware shall be in accordance with AASHTO M-232. High-strength steel bolts, nuts and washers shall meet the requirements of ASTM A-325, except as shown in the Drawings.
- 02890.2.4 **REFLECTIVE MATERIALS TYPE II AND TYPE III REFLECTIVE SHEETING**
- All reflective materials (sheeting, legend, borders and symbols) shall conform to the "Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects," FP, current edition and Federal Specification L-S-300C. Colors shall be as specified in the MUTCD and enclosed drawings. No more than 12 months shall elapse from the date of manufacture to the date of application on the substrate.
- 02890.2.5 **CHARACTERS, SYMBOLS, AND COLORS**
- 02890.2.5.1 **CHARACTERS, SYMBOLS, AND BORDERS** - Letters, numerals, arrows, symbols, border and other features of the sign message shall be of the type, size and series shown on the Drawings.
- 02890.2.5.2 **COLORS** - Colors shall be as specified in MUTCD or shown on the Drawings. Completed letters, numerals and other units shall be formed to provide continuous stroke width with smooth edges and shall present a flat surface free of warp, blisters, wrinkles, burrs and splinters. Units of the sign message of the type shown on the Drawings shall meet the following requirements:
- 02890.2.5.3 **SCREEN PROCESS APPLICATION** (type L-1 Screen Process) - The letters, numerals, arrows, symbols and border shall be applied on the reflective sheeting or opaque background of the sign by

direct or reverse screen process. Messages and borders of a color darker than the background shall be applied to the paint or the reflective sheeting by direct process. Message and borders of a color darker than sign field shall be produced by the reverse screen process.

- Opaque or transparent colors, inks and paints used in the screen process shall be of the type and quality recommended by the manufacturer of the reflective sheeting.
- The screening shall be done in a manner that results in a uniform color and tone, with sharply defined edges of legend and border and without blemishes on the sign background that will affect intended use.
- After screening, signs shall be air dried or baked in accordance with manufacturer’s recommendations to provide a smooth, hard finish. Any signs on which blisters appear during the drying process shall be rejected.

02890.2.5.4 **DIRECT APPLICATION** (type L-3 Direct Applied Characters) - The letters, numerals, symbols, border and other features of the sign message shall be cut from Types II or III reflective sheeting of the color specified in MUTCD or shown in the Drawings and applied to the reflective sheeting of the sign field in accordance with the instructions of the manufacturer of reflective sheeting.

The reflective sheeting shall have minimum reflective intensity (candelas per Foot-candle) as shown below:

MINIMUM REFLECTIVE INTENSITY			
Entrance Angle	White	Yellow	Red
0°	115	70	30
20°	20	25	12

02890.2.6 **DELINEATORS**

The materials to be used for the delineator assembly shall be as shown on the Drawings. The reflectors shall be amber or crystal and ready for mounting. Supporting posts shall be steel, aluminum, wood or other material as shown on the Drawings.

02890.3 CONSTRUCTION REQUIREMENTS

02890.3.1 **FABRICATION OF SIGN PANELS**

All panel fabrication, including cutting, punching and drilling of holes, shall be completed prior to final surface preparation and application of reflective sheeting, except where required for the fabrication of die-cut or sawed letters on processed and mounted signs. Metal panels shall be cut to size and shape and shall be free of buckles, warp, dents, cockles, burrs and defects resulting from fabrication. The surface of all sign panels shall be flat.

Field drilling of holes in any part of the structural assembly will not be permitted without the approval of the Engineer.

02890.3.2 **PANELS**

02890.3.2.1 **ALUMINUM PANELS** - Aluminum sign panels shall be fabricated from standard widths of aluminum sheet. The blanks shall be cleaned, degreased and chromated or otherwise properly prepared in accordance with approved methods recommended by the sheeting manufacturer.

- 02890.3.2.2 **STEEL PANELS** - The panels shall be cleaned, degreased or otherwise prepared in accordance with approved methods recommended by the sheeting manufacturer.
- 02890.3.2.3 **PLYWOOD PANELS** - The face of the plywood panel shall be abraded, cleaned and degreased in accordance with approved methods recommended by the manufacturer of the reflective sheeting. The edges of the plywood panel shall be sealed with 2 mil dry film thickness (in 2 coats); one coat shall be applied before application of reflective sheeting, the other, after.
- 02890.3.2.4 **DURABILITY TREATMENT** - After all reflective sheeting legend has been applied, sign panels with Type II sheeting shall be recycled in the heat and vacuum applicator for 2 minutes at a temperature of approximately 190°F under 21-inches of vacuum. When the sign panel has cooled, the top edge of each sign shall be covered with a clear 3-inch wide polyester film with a sun-resistant, pressure-sensitive adhesive that does not turn yellow under exposure to ultraviolet radiation. Scotchcal Brand Film #639 or Engineer approved equal shall be used. Film shall be applied in lengths of 24-inches. Where more than one piece is required, film shall be applied from each corner of the top edge toward the center of the top edge. End overlap of 2-inches or more shall be required where one film piece joins another piece.
- 02890.3.3 **DELINEATOR POSTS AND HOUSING**
- Delineator posts shall be driven at locations and to the depth shown on the Drawings. The delineator housing shall be attached to the post in accordance with the manufacturer's direction.
- 02890.3.4 **SIGN ERECTION**
- 02890.3.4.1 **SUPPORTS** - Sign supports shall be erected plumb and in accordance with the details shown on the Drawings and in a manner consistent with the U.S Department of Transportation's "Manual of Uniform Traffic Control Devices" to reduce glare.
- 02890.3.4.2 **FASTENING PANELS** - The sign panels shall be securely fastened to the posts as shown on the Drawings.
- 02890.3.5 **SIGN REMOVAL**
- Sign assemblies to be removed shall be shown on the Drawings. Where signs are to be replaced, signs shall be removed just before the installation of replacement signs. All sign materials removed shall become the property of the Contractor. Posts shall be removed to a minimum of 3-inches below natural ground line. Post holes remaining shall be backfilled with suitable material and compacted.
- 02890.4 METHOD OF MEASUREMENT**
- 02890.4.1 Measurement for signs shall be made by (1) counting the number of signs in place and accepted or, (2) by using a tape measure to determine the square footage of panels and the lineal footage of posts (nominal dimensions for wood materials), as shown in the Bid Schedule. No deduction will be made for rounded corners.
- 02890.4.2 Measurement for sign removal shall be made by counting the number of sign assemblies removed and disposed of as listed in the Bid Schedule. An assembly shall be considered as one sign when its materials are integrally connected at a single location.

02890.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for each pay item shown in the Schedule of Items:

PAY ITEM	UNIT
Wood Posts (<i>Size</i>)	Lineal Foot
Steel Posts (<i>Size</i>)	Lineal Foot
Aluminum Posts (<i>Size</i>)	Lineal Foot
Aluminum Sign Panels (<i>Size or Description</i>)	Square Foot
Plywood Sign Panels (<i>Size or Description</i>)	Square Foot
Steel Sign Panels (<i>Size or Description</i>)	Square Foot
Delineators	Each
Sign (<i>Description or Identification</i>)	Each
Sign Removal (<i>Description</i>)	Each
Sign & Post(s) Installation Only	Each

02900.1 DESCRIPTION

This section covers providing materials, equipment and labor necessary for installing topsoil, turf, trees, shrubs, grasses, forbs, field seeding, re-seeding, fertilizer, mulch, and soil amendments.

02900.1.1 RELATED WORK

Not used.

02900.1.2 SUBMITTALS

The Contractor shall submit for approval product data and seed mixtures in accordance with the requirements of Section 01300.

02900.1.3 DEFINITIONS

Not used.

02900.2 MATERIALS**02900.2.1 TOPSOIL**

Topsoil shall be obtained from local sources, and shall have similar soil characteristics to those of the soil at the location where it is to be used. Topsoil shall be obtained from well-drained sites where it occurs to a depth of not less than 4 inches, and it shall not be obtained from bogs or marshes. Topsoil shall be fertile, friable, natural loam, reasonably free of subsoil, clay lumps, brush, weeds, litter, roots, stumps, stones larger than 2 inches in any dimension, or any other material which would inhibit the germination of seeds or the growth of the cover crop.

02900.2.2 TURF SEED

If not otherwise required in the Contract Documents, seed for turf sod shall be composed principally of Kentucky bluegrass (*Poa pratensis*), testing 99.9% pure live seed (PLS), or as approved. Other acceptable varieties include Merion, Baron, Fylking, Tall Fescue, and Brome.

02900.2.3 TURF SOD

Turf sod shall be vigorous, viable, strongly rooted sod, not dormant or less than 2 years old, free of weeds, undesirable native grasses, insect infestations, and fungus. It shall be machine cut to a pad thickness of 1 inch (\pm 0.33 inch).

02900.2.4 TREES AND SHRUBS

02900.2.4.1 NURSERY GROWN - Trees and shrubs shall be nursery-grown, with botanical and common names of plants true to the approved names given in the latest edition of "Hortus", and shall meet the requirements of the American Standard for Nursery Stock adopted by the American Association of Nurserymen. Plants shall be sound, healthy, vigorous, symmetrically proportioned, well branched, densely foliated when in leaf, free of disease, insect pests, eggs, and larvae and shall have well developed root systems.

02900.2.4.2 ROOT BALLS AND PRUNING - Root balls shall be protected at all times from sun, drying winds and frost. Plants shall not be pruned prior to delivery. If balled and burlapped plants are not installed immediately upon delivery, they shall be set on the ground and protected with moist soil or wet mulch.

02900.2.4.3 WARRANTY - Trees and shrubs shall be warranted for a period of 1 year after Substantial Completion, against death and unsatisfactory growth, except in cases resulting from Owner's neglect, abuse by others or natural phenomena. Unacceptable plant material shall be replaced at end of warranty period. Only one replacement is required.

02900.2.4.4 FIELD SEED MIX

The seed mix listed below is suggested as a standard for field seeding when no other information is available. However, seed mix requirements can vary widely from area to area, and the Contractor shall contact the local office of the Natural Resources Conservation Service (NRCS) to obtain an appropriate seed species mix and application rate for the location in question. The Contractor shall follow the directions of the NRCS, the Engineer, and the property owner in doing field seeding.

SUGGESTED FIELD SEED MIX

Species	Amount (%)
Nardan Crested Wheatgrass	30
Russian Wild Rye	20
Y.B. Sweet Clover	15
Slender Wheatgrass	10
Oahe Intermediate Wheatgrass	10
Fairway Crested Wheatgrass	5
Western Wheatgrass	4
Other	6

02900.2.5 RESEEDING AND REVEGETATING

As with the field seed mix, non-field seed mix and/or vegetation requirements are usually area sensitive. Different government agencies, such as the Forest Service or the Bureau of Land Management, may have separate seed mix and vegetation requirements within the same area. The Contractor shall contact the respective property owner at their local office, address, or telephone number to obtain the appropriate reseeding and revegetating requirements and follow the same, in concurrence with the Engineer, in acquiring the appropriate seed and vegetation.

02900.2.6 MULCH

02900.2.6.1 TREE AND SHRUB MULCH - Tree and shrub mulch shall consist of well-aged fibrous or shredded bark, old sawdust, pine needles or leaf mold.

02900.2.6.2 FIELD SEED MULCH - Field seeding mulch shall be certified weed free small grain straw or native hay.

02900.2.6.3 HYDRAULIC MULCH - Hydraulic seeding mulch shall consist of pigments and wood cellulose fiber or paper pulp and shall form a blotter-like ground cover with moisture absorption and percolation properties. It shall have the ability to cover and hold the seed in contact with the topsoil, yet not inhibit the penetration of seedlings through it.

02900.3 CONSTRUCTION REQUIREMENTS

02900.3.1 SCOPE OF REQUIREMENTS

The Contractor shall furnish all equipment, labor, topsoil, seed, seed mixes, turf, shrubs trees or other materials required to landscape, re-seed, or re-vegetate all areas disturbed by the Work, as

required by the Drawings and these Specifications. The disturbed area shall be kept as small as possible.

02900.3.2 **EROSION CONTROL**

The condition of landscaped, re-seeded and re-vegetated areas shall be checked to determine the effectiveness of erosion control methods and materials. Checks will be made upon project completion, at three months following project completion, and at nine months following project completion. Any modifications or repairs required by the Engineer shall be promptly performed by the Contractor, at no additional cost to the Owner.

02900.3.3 **TOPSOIL**

02900.3.3.1 **REMOVAL OF TOPSOIL** - Topsoil to be saved shall be carefully removed to a depth of 24 inches, or to the actual depth of the existing layer, which ever is less, and set aside in a separate location. It shall not be mixed with the remainder of excavated material.

02900.3.3.2 **REPLACEMENT OF TOPSOIL** - When site work conditions permit, topsoil shall be spread as shown on the Drawings. The minimum depth of topsoil shall be 6 inches over all designated areas. Topsoil shall be fine graded to a firm even surface, matching existing slopes, with no lumps or stones present. The topsoil shall be prepared to a good condition, not muddy or hard, and shall be scarified to a friable condition if it is hard before turf is placed.

02900.3.3.3 **PROTECTION AGAINST EROSION** - Areas where topsoil has been spread shall be protected against erosion.

02900.3.4 **TURF SEED**

02900.3.4.1 **SEEDBED PREPARATION** - Where required, turf seed shall be installed as specified herein. Seedbed preparation shall be accomplished by spreading peat moss or manure uniformly at a rate of 3 cubic yards per 1000 square feet and worked into the soil by light tilling.

02900.3.4.2 **APPLICATION** - Seed shall be applied at a rate of 2 pounds per 1000 square feet using a drop (band) type spreader unless otherwise approved by the Engineer. The seed shall be divided into two halves and then distributed, half in north/south directions and half in east/west directions. Seed shall be raked into the soil, a layer of mulch shall be applied, and then lightly watered, at least four times daily for two weeks, or until the seed germinates.

02900.3.5 **TURF SOD**

02900.3.5.1 **INSTALLATION** - Where required, turf sod shall be laid across slopes such that butt joints alternate. Sod pieces shall be fitted tightly together so no joint is visible and then firmly and evenly hand tamped. The sod shall then be rolled with a 150-pound roller to level and seal all seams.

02900.3.5.2 **WATERING** - After rolling, sod shall be watered until water soaks into underlying topsoil to a depth of not more than 3 inches. For grades of 50% slope or steeper, the sod shall be secured with wooden pegs driven flush with the soil portion of the sod and 2 feet maximum on center.

02900.3.5.3 **MOWING** - Prior to Substantial Completion, sod shall be mowed as required to maintain a maximum height of 2 1/2 inches.

02900.3.6 TREES AND SHRUBS

02900.3.6.1 **LOCATION** - When required trees and shrubs shall be installed, as specified herein, at locations designated on the Drawings. Trees and shrubs to be saved and replanted shall be carefully removed, set aside, protected and preserved until they can be safely replanted.

02900.3.6.2 **PREPARATION OF PLANTING PIT** - Tree and shrub pits shall be five times the diameter of the root ball. The bed shall be prepared by loosening the soil with a tiller or shovel to a depth of 12 inches. Topsoil and organic matter shall then be added and distributed uniformly within the planting bed as necessary. The Contractor shall not proceed with planting until the pit locations and bedding are approved by the Engineer.

02900.3.6.3 **PLANTING** - The plant shall be set in the center of a hole of the proper size, plumb and straight. Burlap, ropes and all wire and other materials shall be removed, and then the excavated soil shall be returned to the hole and gently packed around the root ball. The planting shall be flooded with water to promote additional soil consolidation. The Contractor shall give care that, after settling, the top of the root collar shall be even with the adjacent finished grade. A 2-inch layer of mulch shall be applied around the base of the tree, to extend 2 feet in radius beyond the root ball.

02900.3.6.4 **SUPPORT** - Trees shall be guyed with two wires anchored securely to steel posts not less than 5 feet from the trunk, and directly opposite each other. The trees shall be protected from direct contact with the wires.

02900.3.6.5 **PRUNING** - Each plant shall be pruned with clean, sharp tools, to remove suckers and broken, badly bruised or dead branches. Tree trunks shall be wrapped with Tubex or equivalent translucent material unless directed otherwise by the Engineer.

02900.3.6.6 **WATERING** - Trees and shrubs shall be watered and maintained until Substantial Completion and defective work shall be corrected as soon as it becomes apparent and as weather and season permit.

02900.3.7 FIELD SEEDING

Field seeding shall be accomplished using one of the following methods.

02900.3.7.1 **BROADCAST** - Broadcast seeding shall only be applied after October 15 and prior to April 15, unless authorized otherwise and directed in writing by the Engineer. No seed bed preparation will be required for this seeding method.

02900.3.7.2 **DRILLING** - Drilling shall be set forth in uniform rows with spacing not to exceed 8 inches and the depth set correctly for the type of seed being drilled. The minimum distribution rate shall be 20 pounds per acre, and may be more if so recommended by the local Soil Conservation Service.

02900.3.7.3 **HYDRAULIC** - For hydraulic seeding the Contractor shall use equipment designed for such work. Seed and water shall be uniformly applied to the areas scheduled to be seeded. Fertilizer, water and approximately 1 ton per acre of hydraulic mulch shall be homogeneously mixed and uniformly applied to seeded areas.

02900.3.8 RESEEDING AND RE-VEGETATING

02900.3.8.1 **RE-SEEDING** - Reseeding of areas disturbed by the Work shall be accomplished with grasses compatible with the pre-construction vegetation. The Contractor shall consult the local office of the U.S. Forest Service, Bureau of Land Management, Soil Conservation Service, or other applicable affected agency, for appropriate seed species and application rates. Unless otherwise

directed by the Engineer or these Specifications, reseeded shall be accomplished by broadcast seeding in accordance with this section.

02900.3.8.2 RE-VEGETATING - Re-vegetation of areas disturbed by the Work shall be accomplished with started trees and shrubs, compatible with the pre-construction vegetation, and is performed in addition to reseeded as discussed in paragraph 02900.3.8.1 above. When re-vegetation is required, the Contractor shall consult the local office of the applicable affected agency, for appropriate species and instructions.

02900.3.9 MULCH

Mulch shall be incorporated as prescribed on the Drawings and in these Specifications. Where the slope exceeds 10%, the Contractor shall use a tie down mulching material.

02900.4 METHOD OF MEASUREMENT

02900.4.1 LUMP SUM - Lump sum measurement for landscaping shall include all grading, soil preparation, planting, furnishing materials and plants in accordance with the Drawings and these Specifications when shown as a single item in the Bid Schedule.

02900.4.2 SEPARATE MEASUREMENT - When and if applicable, separate measurements for topsoil, turf seeding, turf sod laying, reseeded, re-vegetating, mulching and planting of trees and shrubs shall be made in the units shown and as identified in the Bid Schedule.

02900.5 BASIS OF PAYMENT

The accepted quantity(s) shall be paid for at the contract unit price for:

PAY ITEM	UNIT
Landscaping	Lump Sum
Topsoil	Square Yard
Turf, Seed	Square Foot
Turf Sod	Square Foot
Trees & Shrubs	Each
Field Seeding	Acre
Re-seeding	Acre
Mulch	Acre

SPECIAL PROVISION

LANDSCAPING

**SECTION
SP 02900**

Revise the following paragraph in Section 02900.3 of the Standard Specifications to read as follows:

02900.3.3 TOPSOIL

02900.3.3.1 REMOVAL OF TOPSOIL - Topsoil to be saved shall be carefully removed to a depth of 24 inches, or to the actual depth of the existing layer, which ever is less, and set aside in a separate location. It shall not be mixed or contaminated with the remainder of excavated material or any other deleterious material.

02900.3.3.2 REPLACEMENT OF TOPSOIL - When site work conditions permit, topsoil shall be spread over those areas from where it was removed. The depth of topsoil shall be 6-inches minimum or to the preconstruction depth of not greater than 24-inches, which ever is greater, over all designated areas. Topsoil shall be fine graded to a firm even surface, matching existing slopes, with no lumps or stones present. The topsoil shall be prepared to a good condition, not muddy or hard, and shall be scarified to a friable condition if it is hard before turf is placed.

Add the following paragraph to Section 02900.3 of the Standard Specifications:

02900.3.6.7 REMOVAL – Trees shall be delimbed and hewn to protect against the damage of existing above ground utilities, personal property, and general safety of the public. Once delimbed and hewn to the ground level, they shall be carefully uprooted while protecting against damage to underground utilities. All portions of the tree sections shall be hauled to the county landfill or disposed of according to county regulations and ordinances. Area surrounding tree to be removed shall be restored to its original condition prior to removal. No separate measurement will be made for property restoration in conjunction with tree removal.

Revise the following paragraph in Section 02900.4 of the Standard Specifications to read as follows:

02900.4.2 SEPARATE MEASUREMENT – When and if applicable, separate measurement for topsoil, turf seeding, re-vegetating, mulching, planting of trees and shrubs, and removal of trees and shrubs shall be made in the units shown and as identified in the Bid Schedule.

Add the following pay item in Section 02900.5 of the Standard Specifications:

PAY ITEM	UNIT
Tree Removal	Each

02950.1 DESCRIPTION

This section covers furnishing and installation of geotextile fabric of the type and configuration shown on the Drawings or specified in the Contract Documents.

02950.1.1 RELATED WORK

Section 02200 - Trench Excavation and Backfill
 Section 02202 - Roadway Excavation and Embankment
 Section 02201 - Earthwork for Structures

02950.1.2 SUBMITTALS

The Contractor shall submit manufacturer’s descriptive literature, which identifies and describes applications, physical properties and characteristics of geotextile filter fabric materials to be used for this contract, in accordance with Section 01300 of these Specifications. Upon request of the Engineer, the Contractor shall supply samples for examination or testing.

02950.1.3 DEFINITIONS

Not used.

02950.2 MATERIALS

02950.2.1 FOR RIPRAP AND DRAINAGE CHANNELS

Unless shown otherwise on the Drawings or in Contract Documents, filter fabric materials for installation under riprap in drainage channels, or for lining structural footing drainage components shall be TREVIRA Spunbond type 011/250, MIRIFI 180/N or an approved equal with the following characteristics:

FILTER FABRIC CHARACTERISTICS

Grab Tensile Strength, ASTM D-4632	210 lb.
Elongation at Failure, ASTM D-4632	50%
Trapezoid Tear Strength, ASTM D-4533	75 lb.
Puncture Strength, ASTM D-4833	95 lb.
Mullen Burst Strength, ASTM D-3786	360 psi.
Permeability - k, ASTM D-4491	0.3 cm/sec.
Permittivity, ASTM D-4491	1.4 sec ⁻¹
Vertical Water Flow, ASTM D-4491	110 gpm/ft ²
Apparent Opening Size*, ASTM D-4751	0.210 mm

*Maximum Opening Size

02950.2.2 FOR EMBANKMENTS AND FOUNDATIONS

Requirements for geotextile fabric materials used for embankment or foundation stabilization other than that specified above will be provided in the Special Provisions of the Contract Documents.

02950.3 CONSTRUCTION REQUIREMENTS

Filter fabric materials shall be installed in strict accordance with the manufacturer’s instructions and recommendations. Care shall be taken at all times to prevent puncturing or tearing of the

fabric materials during placement under embankment or riprap materials. Joints of fabric sheets shall be lapped in accordance with the manufacturer's instructions and fastened securely in place with fasteners to prevent gaps and misalignment during coverage with earth materials.

02950.4 METHOD OF MEASUREMENT

02950.4.1 Geotextile fabrics will be considered incidental to installation of riprap and drainage gravel envelopes and no separate measurement shall be made.

02950.4.2 When shown separately as an item in the Bid Schedule, geotextile fabric shall be measured to the nearest tenth square yard determined from field measurements of surface areas on which each type of the fabric is installed, excluding overlaps.

02950.5 BASIS OF PAYMENT

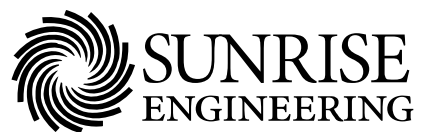
02950.5.1 When geotextile fabric materials are furnished and installed incidental to other items in the Bid Schedule, no separate payment shall be made.

02950.5.2 When shown in the Bid Schedule as a separate item, the accepted quantities will be paid for at the contract unit price for:

PAYMENT ITEM	UNIT
Geotextile Fabric (<i>Type</i>)	Square Yard

DIVISION 3

CONCRETE



03050.1 DESCRIPTION

This section contains requirements for Portland cement concrete materials and concrete mix designs.

03050.1.1 RELATED MATERIALS AND WORK

Section 03100 - Concrete Forming, Finishing and Curing
Section 03200 - Concrete Reinforcement
Section 03300 - Concrete Structures and Slabwork
Section 03500 - Pre-Cast Concrete Components
Section 03600 - Grout and Mortar

03050.1.2 SUBMITTALS**03050.1.2.1 PROPOSED MIX DESIGN** - Each proposed mix design shall be submitted at least 14 days prior to its use in the Work. Indicate whether mix has been designed for pumping. Mix design submittals shall include the following information:

- Water-cementitious materials ratio (w/cm).
- Proportion of materials in the mix.
- Source and type of cement.
- Analysis of water to be used, unless potable.
- Type and name of admixtures applied. Indicate when accelerating or retarding admixtures are to be used and the resulting change in placement times.
- Slump, air content, and temperature of samples.
- Unit weights of fresh and dry light weight concrete.
- Any applicable and verifiable test documentation available if the submitted mix design has been used by the CONTRACTOR in prior projects.

03050.1.2.2 AGGREGATE TEST REPORT - Aggregate Test Report (submit for each aggregate source):

- Data of test analysis.
- Sieve analysis.
- Organic impurities.
- Sodium sulfate soundness test.
- Reactivity of aggregate.
- Complete identification of source of aggregate.

03050.1.2.3 CHANGES IN MIX DESIGN - After the design of the mix or mixes has been approved by the Engineer, neither the source, character, or grading of the aggregate, nor the brand or type of cement shall be changed, without 48 hours written notice to the Engineer. Should such changes become necessary, no concrete containing such new or altered materials shall be placed until the revised mix design has been submitted to the Engineer for review and approval.**03050.1.3 DEFINITIONS**

Workability - The ease of placing, consolidating and finishing freshly mixed concrete.

Consolidation - Hand rodding or mechanically vibrating actions which give freshly mixed concrete the characteristics of a thick fluid to minimize voids when set.

Hydration - The chemical reaction between water and calcined limestone resulting in the excellent bonding properties of the cement particles with one another and with the aggregates in the mix.

Curing – The process necessary to provide adequate moisture, temperature, and time to allow concrete to achieve the desired properties for its intended use. The time is generally construed to mean the period required for concrete to attain 70 percent of the specified compressive strength, which is about seven days.

Strength - The maximum resistance of a mortar or concrete specimen to axial compressive loading expressed in psi.

Admixtures - Chemical additives to concrete mixes intended to adjust setting time, reduce water demands, increase workability and entrain air.

Air Entrainment - Introduction of chemicals to concrete mixtures which produce microscopic air bubbles which improve the workability and ability to resist deterioration due to freezing.

Reinforcement - Materials formed or mixed in concrete mixtures, to increase the ability of the concrete to withstand loading when set (hardened).

Water-Cementitious Materials Ratio - The weight of the water divided by the weight of the cement plus supplementary cementitious materials in a concrete mixture.

Tempering - The addition of water to mixed concrete after arrival on site.

03050.2 MATERIALS

03050.2.1 CEMENT

03050.2.1.1 SITE-PLACED CONCRETE - For site-placed concrete, cement shall be Type II (low alkali) cement, meeting requirements of ASTM C-150, unless otherwise directed by the Engineer or these Specifications. Do not use cement containing lumps, or cement which has partially set. Do not mix cements originating from different sources or manufacturers.

03050.2.1.2 PRE-CAST CONCRETE - For pre-cast concrete, cement shall be Class 5000 (minimum) in accordance with ACI 318 for units to be installed above ground. For units installed below ground, concrete shall be Class 4000 in accordance with ASTM C 478 and ASTM C 858.

03050.2.2 WATER

Shall be potable or water which meets the requirements of ASTM C1602.

03050.2.3 REINFORCEMENT

Shall be in accordance with Section 03200 of these Specifications.

03050.2.4 ADMIXTURES

03050.2.4.1 AIR ENTRAINMENT - Air entrainment of concrete shall meet the requirements of AASHTO M-154 (ASTM C-260).

03050.2.4.2 PLASTICIZERS - Water reducing agents (plasticizers) and set retarding agents shall meet the requirements of AASHTO M-194 (ASTM C-494). Only types A or F will be approved as water reducing agents, only types C and E will be approved as set accelerating agents, and only types B,

D, or G will be approved as set retarding agents. Water reducing, set accelerating, and set retarding agents shall be pre-measured and added in strict accordance with manufacturer's instructions. Calcium chloride will not be approved.

03050.2.4.3 FLY ASH - Pozzolan (fly ash) may be used to replace a percentage of cement in the mix design in accordance with ASTM C-618, Class C and Class F, under the following conditions:

- The minimum required cement content shall be expressed in the design formula before replacement calculations are made.
- The amount of Portland cement replaced by pozzolan shall not exceed 15% for exterior concrete (concrete exposed to weather) and 20% for interior concrete.
- The ratio of replacement by weight of pozzolan to cement shall be 1.25 to 1.0.
- Loss of ignition of pozzolan shall be less than 3 percent, and the water requirement shall not exceed 100 percent.
- All other requirements of this Section still apply.
- Mix designs including trial batches are required for each aggregate source and for each concrete class.
- See also Subsection 03050.2.6.4 below.

03050.2.5 AGGREGATE

03050.2.5.1 AGGREGATE RATIO - The combined weight of coarse and fine aggregate material passing the No. 200 sieve shall not exceed 1.75 percent of the total weight of aggregate. The ratio of coarse to fine aggregate shall not be less than one (1) nor more than two (2), nor shall the amount of coarse aggregate be great enough to cause difficulty in concrete placement or honeycombing in the structure.

03050.2.5.2 COURSE AGGREGATE - Coarse aggregate shall comply with AASHTO M-80, using gradations from the following table:

COARSE AGGREGATE GRADATIONS

Aggregate Size	Percent Passing (by weight)							
	Sieve Size							
	2½"	2"	1½"	1"	¾"	½"	⅜"	No. 4
2" to No. 4	100	95-100		35-70		10-30		0-5
1½" to No. 4		100	95-100		35-70		10-30	0-5
1" to No. 4			100	95-100		25-60		0-10
¾" to No. 4				100	90-100		20-55	0-10

Maximum coarse aggregate gradation shall not be larger than 1/5 of the narrowest dimension between sides of forms; shall not be larger than 1/3 the depth of slabs; shall not be larger than 3/4 of the minimum clear distance between reinforcing bars or between bars and forms, whichever is less; and shall not be larger than 2 inches.

The maximum percentage by weight of deleterious substances allowed in coarse aggregate materials shall be:

**DELETERIOUS SUBSTANCES ALLOWED IN COARSE
AGGREGATE**

Substance	Percent
Soft fragments	2.0
Coal and lignite	0.3
Clay lumps	0.3
Other deleterious substances	2.0

03050.2.5.3 FINE AGGREGATE - Fine aggregate shall comply with AASHTO M-6 using gradations from the following table:

FINE AGGREGATE GRADATIONS

Sieve Size	Percent Passing (by weight)
3/8-inch	100
No. 4	95 to 100
No. 16	45 to 80
No. 50	10 to 30
No. 100	2 to 10

The maximum percentage by weight of deleterious substances allowed in fine aggregate shall be:

DELETERIOUS SUBSTANCES ALLOWED IN FINE AGGREGATE

Substance	Percent
Coal and lignite	0.3
Clay lumps	0.5
Other deleterious substances	2.0

03050.2.5.4 AGGREGATE SOUNDNESS AND REACTIVITY - As determined in accordance with ASTM C-88, potentially deleterious aggregates shall not be used unless service records have shown the aggregates to be innocuous, and the Engineer subsequently approves them in writing.

03050.2.6 MIXING REQUIREMENTS

03050.2.6.1 CONCRETE CLASSIFICATIONS - Mixing requirements for the specific concrete classes indicated on the Drawings and/or within these Specifications shall be as follows:

CONCRETE CLASSIFICATIONS

Concrete Properties	Concrete Classifications			
	5000	4000	3500	2000
Coarse Aggregates (see requirements shown below)				
Maximum Water/Cement Ratio (gal/sack)	5.0	6.0	6.5	8.0
Minimum Cement Content (sacks/CY)	***	***	6.0	4.5
Slump (inches)**	2 to 4	2 to 4	2 to 4	2 to 5
Air Content (percent)	5.0 to 7.5	5.0 to 7.0	5.0 to 7.0	3.0 to 5.0
Required Average 28 Day Compression Strength Test (psi)****	5200	4200	3700	2200
Required Minimum 28 Day Compression Strength Test (psi)****	4800	3800	3300	1800

Notes: * All concrete installed shall be Class 3500 unless otherwise required in the Contract Documents.

** When water reducing agents are not used.

*** Cement content shall be appropriate to produce a mixture meeting the requirements for water/cement ratio and workability for the specific job conditions.

**** One compressive strength test shall consist of the average strength of two cylinders in the test sample.

03050.2.6.2 **REQUIRED AVERAGE DAY COMPRESSIVE STRENGTH** - The CONTRACTOR shall furnish and install concrete that will produce a Required Average (28) Day Compressive Strength as shown on the table above. The average of any three consecutive (28) day strength tests shall not fall below the required Minimum (28) Day Compressive Strength Test shown. If the average of any three consecutive tests falls below the Required Minimum, the average strength of the concrete shall be increased at the CONTRACTOR's expense by increasing the cement content.

03050.2.6.3 **WATER REDUCING AGENTS** - When water reducing agents (plasticizers) are used in the concrete mixtures shown above, maximum slump requirements may be increased to 5 inches with low range water reducers and to 8 inches with high-range water reducers.

03050.2.6.4 **FLY ASH** - When fly ash is used in the mix, the cement in the water/cement ratio denotes the cement and fly ash combined. Cement shall be introduced into the batcher before the fly ash.

03050.2.6.5 **CONCRETE PLACED IN WATER** - For concrete deposited in water, add one additional bag of cement per cubic yard more than the design requires for concrete placed above water or add an anti-washout admixture, approved by the submittal process, per manufacturer recommendations.

03050.3 CONSTRUCTION REQUIREMENTS

03050.3.1 STORING CEMENT

Bagged and bulk cement shall be stored in weatherproof enclosures to exclude moisture and contaminants.

03050.3.2 STOCKPILING AND HANDLING AGGREGATE

03050.3.2.1 **CLEAN SITE** - The site provided for stockpiling aggregates shall be clean with adequate space to provide separate stockpiles for coarse and fine aggregates.

03050.3.2.2 **WASHING AGGREGATE** - Washed aggregates shall be allowed to drain to a uniform moisture content, and stockpiles shall be built at least 48 hours before use.

03050.3.2.3 **HEIGHT** - Aggregate shall not be dropped more than 10 feet from the conveyor, nor shall cone shaped piles more than 10 feet high be built.

03050.3.2.4 **STOCKPILE LAYERING** - Stockpiles shall be built in thin layers (5 feet maximum) in such manner, to prevent spillage of aggregate over the sides of the stockpile.

03050.3.2.5 **FROZEN MATERIALS** - Stockpiles containing snow, ice, or frozen materials shall not be used.

03050.3.3 BATCHING MATERIALS

03050.3.3.1 **SCALES** - The CONTRACTOR shall provide scales or arrange for usage of scales that have been certified by State agencies within the past 12 months.

- 03050.3.3.2 BATCH MIXERS - Batch mixers shall be operated at the manufacturer's recommended drum speed. Drums and blades shall be kept free from excessive cement and mortar build up. Cement shall be introduced into the batcher before fly ash, and all admixtures shall be introduced to the mixer separately.
- 03050.3.3.3 CENTRAL MIXING PLANT - At central mix plants, all materials shall be mixed for at least 80 seconds at recommended drum speed. When more water is added to the cement mixture, the materials shall be mixed for an additional 30 seconds.
- 03050.3.3.4 MIXING PERIOD - The mixing period for truck mixers shall be maintained between 70 and 100 revolutions at mixing speed. Maintain a minimum of 90 revolutions for front end discharge trucks. Concrete mixing shall be completed before the truck leaves the batch plant yard.
- 03050.3.3.5 WATER REDUCING AGENTS - If water reducing agents are added at the site, they shall be added using injection equipment capable of rapidly and uniformly distributing the admixture. Prior to discharge, the concrete shall be mixed for a minimum of 5 minutes at a drum rate not less than 12 rpm or more than 15 rpm discharge.
- 03050.3.4 HEATING AGGREGATE AND WATER
- 03050.3.4.1 HEATING EQUIPMENT - When approved by the Engineer, the CONTRACTOR, at its own expense, may provide and operate heating equipment to heat aggregate and water because of cold weather conditions. All heating operations shall meet temperature limitations provided in these Specifications and shall conform to Standard ACI 306. The CONTRACTOR shall ensure that excessive heat does not cause "flash set" when the cement is added.
- 03050.3.4.2 UNIFORM HEATING - Aggregates shall be heated uniformly with steam or dry heat. Water shall be heated to between 70°F and 150°F when introduced into the mixer. Measures shall be taken to prevent overheating and hot spot development. No combustion products (ash, smoke, gas and etc.) shall contact the aggregate.
- 03050.3.5 COOLING CONCRETE MIXTURE
- 03050.3.5.1 COOLING EQUIPMENT - When approved by the Engineer, the CONTRACTOR, at its own expense, may provide and operate equipment to refrigerate water, provide ice or cool aggregate, to mix concrete due to hot weather conditions. All methods of cooling shall meet the requirements of ACI 305.
- 03050.3.5.2 USE OF ICE - When ice is introduced into the mixer, it shall be accounted for as mix water in the batching process and it shall be in such form as to be completely melted and dispersed throughout the mix at the completion of the mixing time. The mixing time shall be held to the minimum practicable, consistent with producing concrete meeting the specified requirements.
- 03050.3.6 CONCRETE TRANSPORT
- 03050.3.6.1 TRUCKS - Concrete mixtures shall be transported only in conventional transit mixers or agitator trucks with rating plates that are readable. Trucks shall be equipped with visible water meters and revolution counters and shall be capable of measuring all water introduced into the mixing drum.
- 03050.3.6.2 LOADING - Trucks shall not be loaded:
- In excess of their rated mixing capacity, or
 - In excess of 63 percent of the drum gross volume, or

- In quantities less than 2 cubic yards

03050.3.7 CONCRETE TEMPERING**03050.3.7.1 ADDING WATER – Concrete may be tempered through the addition of water under the following conditions:**

- Water shall be added within specified time limits. At no time shall water be added after testing has taken place.
- Wherever possible, water shall be added after the truck leaves the batch plant.
- Water shall not be added in excess of the water/cement ratio or in excess of that specified on the batch tickets.
- The mixing drum shall be rotated at least 30 revolutions at the manufacturer's recommended mixing speed when water is added, OR, addition of water for tempering shall be followed by 3 minutes of mixing at mixing speed prior to discharge.
- Water shall not be added after 1/2 cubic yard or more of concrete has been discharged from the drum.

03050.3.7.2 LOW SLUMP - When concrete arrives at the site with a slump below specification, the CONTRACTOR may temper the mix up to the maximum approved water/cement ratio, provided:

- The mix design allows for on-site water addition;
- The amount of water added is accurately measured to the nearest gallon;
- The maximum slump is not exceeded; and
- The person adding water is approved to do so by the Engineer and the concrete supplier.

03050.3.7.3 TEMPERING WITH PLASTICIZER - Do not deliver concrete containing plasticizer to the site unless the batch delivery ticket displays water/cement ratio prior to plasticizer addition. Tempering with plasticizer after delivery time window expiration shall not be allowed.**03050.3.8 CONCRETE PLACEMENT**

Shall be in accordance with Section 03300.

03050.3.9 CONCRETE SAMPLING AND TESTING**03050.3.9.1 PROCEDURE -The CONTRACTOR shall be responsible for all required sampling and testing of concrete during construction, including slump, air entrainment, strength and temperature. All testing for concrete used on this project shall be performed by an independent certified testing facility and its personnel. The CONTRACTOR shall obtain the Engineer's approval of the independent certified testing facility at least ten (10) days before any project field work is started. Approval of the CONTRACTOR's independent certified testing facility shall be based on a statement of qualifications, which shall be submitted to the Engineer. All costs for sampling and testing in accordance with the project specifications shall be paid by the CONTRACTOR.**

03050.3.9.2 SAMPLING FREQUENCY - Concrete sampling frequency shall be as noted below:

- A minimum of one air test (ASTM C-231 or C-173) and one slump test (ASTM C 143) shall be performed for each placement over 5 cubic yards. At least one air and one slump test shall be performed for each additional load of concrete placed.
- For each test, the concrete temperature and the time shall be verified and recorded. Air and slump test results shall be recorded on batch delivery tickets.
- If an air test fails, immediately retest the same load. The concrete shall be rejected if the second air test fails to meet specified requirements. If the second air test meets specified requirements, a third test will be performed to establish concrete acceptance or rejection.
- If the slump for an individual load cannot be corrected by tempering within the mix design requirements and within the requirements of these Specifications, the load shall be rejected.
- The testing facility shall prepare test cylinders for strength testing in accordance with ASTM C-31 and execute compressive strength testing in accordance with ASTM C-39.
- At least one strength test shall be performed for each placement over 5 cu. yd., and one additional test for every 50 cu. yards of concrete placed or more frequently at the Engineer's discretion. The number of cylinders for a valid 28-day compressive strength test shall be determined in accordance with ACI 301 and 318. If the cylinders are 6"x12", two are adequate for a 28-day test. If the cylinders are 4"x8", three are required. One cylinder from each test may be set aside at the CONTRACTOR's request for strength verification prior to form removal. The average compressive strength of the two or three cylinders constitutes one compressive strength test.
- The CONTRACTOR shall provide space in the work area and protect sample cylinders from disturbance for 24 hours after they are cast or until they are moved from the work area by testing laboratory personnel or under the direction of the Engineer.
- The average compressive strength shall meet the requirements shown in the table in Section 03050.2.6.1 for the class of concrete placed.

03050.4 METHOD OF MEASUREMENT

Measurement for concrete placed in accordance with these Specifications shall be as described in Section 03300.

03050.5 BASIS OF PAYMENT

Acceptable quantities of concrete, when measured separately, shall be paid for at the contract unit prices described in Section 03300.

SPECIAL PROVISION

XYPEX

**SECTION
03051SP**

03051.1 DESCRIPTION

XYPEX is an admixture to concrete and shall be Xypex C-500 as supplied by Xypex Chemical Corp. through IMX Technologies and local Ready Mix Supplier. This Admixture is a dry powder compound consisting of Portland cement, very fine treated silica sand and various active proprietary chemicals. Xypex causes a catalytic reaction that generates a non-soluble crystalline formation of dendritic fibers within the matrix of the concrete, permanently sealing the concrete from the penetration of liquids and chemicals.

03051.1.2 RELATED MATERIALS AND WORK

APWA Specifications

1. DIVISION 00
2. DIVISION 03

03051.1.2.3 SUBMITTALS

The Contractor will be required to submit Concrete Mix Designs for the following:

1. Class 4000 without Xypex admixture.
2. Class 4000 with Xypex admixture.

03051.2 MATERIALS

03051.2.1 PRODUCT USAGE AND RATE: All concrete formed or placed for the raw water tank shall contain Xypex at an admixture rate of 10 pounds per cubic yard of concrete or as required by the manufacturer.

03051.2.2 Product must meet the following criteria:

1. Must resist aggressive chemicals (3-11 constant contact, 2-11 periodic contact) (A.S.T.M. C267-77, A.S.T.M. C672-76)
2. Must allow concrete to breathe. Must prevent water vapor buildup
3. Product must be non-toxic, N.S.F 61, E.P.A. and other environmental approvals.
4. Must make the concrete self-healing. Heal hairline cracks up to .04 mm (1/64")
5. Treated concrete must withstand 175 PSI with no measurable leakage (U.S. Army Corps of Engineers CRD-C-48-73)
6. Penetration: Must show at least 2" (50MM) penetration of crystal-forming material as evidenced by Scanning Electron Microscope (S.E.M.) photographs.
7. Compressive Strength: At least 10 percent increase in strength compared to samples prepared without admixture, when testing in accordance with ASTM C 39/C 39M after 28 days.
8. Crystalline Waterproofing Manufacturer must have at least 10 year history, showing compliance with specified performance characteristics and ability to provide test report data and support personnel on site as necessary.
9. Batch Plant, and Installers must be Certified in the use of Crystalline Waterproofing.
10. Must provide a ten year warranty. See: www.imxtechnologies.com , click warranty

03051.2.3 ALTERNATE to Xypex Admix. Contractor may submit an alternate product or method of construction to the engineer, for review and approval. The product or method will be evaluated against design effects described above and must include the following criteria below:

1. Product or method must add compressive strength to concrete as per 03051.2.2 - 6.

SPECIAL PROVISION

XYPEX

**SECTION
03051SP**

2. Product or method cannot be subject to puncture, tearing, or seam release.
3. Product or method cannot be subject to failure due to poor installation practices.
4. Product or method must protect rebar within the concrete from corrosion, and oxidation.
5. Product or method must reduce shrinkage cracking as shown by appropriate testing.
6. Product or method must allow the concrete to breathe.
7. Product or method must waterproof the concrete to withstand 175 PSI as per 03051.2.2 - 5.
8. Product or method must allow concrete to self-heal as per 03051.2.2 - 4
9. Product or method must densify concrete as 03051.2.2 - 6 and S.E.M photography.
10. Product or method must give concrete ability to resist chemicals as per 03050.2.2 - 1
11. Product or method must be environmentally sensitive as per 03051.2.2 - 3.
12. Product or method must provide a ten year leak proof warranty.
13. Product or method must eliminate or reduce effect of freeze-thaw cycling, internal expansion, spalling, efflorescence, and other concrete conditions.

03051.3 METHOD OF MEASUREMENT

Measurement for concrete placed in accordance with these Specifications shall be as described in APWA Specification Division 01.

03050.4 BASIS OF PAYMENT

This item shall be paid as part of the concrete as a Lump Sum payment item for concrete work on the different Bid Schedule items where concrete is required.

03100.1 DESCRIPTION

Includes furnishing materials, accessories and labor required to form, finish and cure interior and exterior cast-in-place concrete.

03100.1.1 RELATED WORK

Section 03050 - Portland Cement Concrete
Section 03200 - Concrete Reinforcement
Section 03300 - Concrete Structures and Slabwork
Section 03500 - Precast Concrete Components
Section 03600 - Grout and Mortar

03100.1.2 SUBMITTALS

03100.1.2.1 SHOP DRAWINGS - When called for in these Specifications, the CONTRACTOR shall furnish shop drawings of forms for specific concrete items. Such drawings shall show general construction of forms, jointing, location of ties and other items affecting visibility.

03100.1.2.2 FORM RELEASE AGENT - Where concrete surfaces are scheduled to receive special finishes or applied coverings, which may be affected by the form release agent, submit manufacturer's instruction for use of agent.

03100.1.2.3 CHEMICAL HARDENER - Submit name, type, chemical analysis and manufacturer's recommended rate of application for chemical hardener, when specified.

03100.1.2.4 CURING COMPOUNDS - Submit manufacturer's specifications, test information, ingredients, certification, and installation recommendations for curing compounds. This information may become the basis of acceptance or rejection of the work cured by the material used. See also the submittal requirement under Membrane Curing Compounds in 03100.3.6.2 herein.

03100.1.3 DEFINITIONS

Shoring - The framework installed to support formwork.

Re-Shoring - Framework installed or not removed which serves as support for form-work after concrete sets and there is less need for the support.

Form Coatings - Compound coated on forms, preventing concrete surface bonding to the forms.

Curing Compound - Liquid medium sprayed or coated on concrete to retain moisture.

03100.2 MATERIALS**03100.2.1 FORM TIES AND SPREADERS**

Shall be removable or snap-off metal, designed to prevent form deflection and to prevent spilling on concrete surfaces upon removal. Form ties shall be factory fabricated. Field fabricated ties will not be acceptable. The portion of the tie remaining within concrete after removal of exterior parts should be 1 inch below the outer concrete surface, and the remaining hole in the concrete surface shall not be larger than 1-inch diameter, unless approved otherwise by the ENGINEER.

03100.2.2 JOINT FILLER

Shall be furnished and installed in accordance with Section 03310 herein.

03100.2.3 FORM RELEASE AGENTS

Commercial formulation form release agent compounds shall be used. Form release agents shall not bond with, stain or adversely affect concrete surfaces requiring later bond or adhesion. They shall not impede the wetting of surfaces to be cured with water or curing compounds. Surplus oil on forms and form oil on reinforcing steel and construction joints shall be removed before concrete is placed.

03100.2.4 FILLETS FOR CHAMFERED CORNERS

Shall be wood strips 3/4 inch by 3/4-inch size and of maximum possible length.

03100.2.5 MORTAR AND GROUT

Shall be furnished in accordance with Section 03600 herein.

03100.2.6 LIQUID CHEMICAL HARDENER

Shall be a colorless aqueous solution, containing a blend of magnesium fluosilicate, zinc fluosilicate and a wetting agent. The mixture shall contain not less than 2 pounds fluosilicate per gallon and shall not interfere with adhesives and the bonding of finishes where such is indicated.

03100.2.7 WATER

Water for curing shall meet the requirements of Section 03050 herein.

03100.2.8 MOISTURE RETAINING SHEETING

Shall be white, waterproof paper, polyethylene film or burlap-polyethylene sheet which meets the requirements of ASTM C-171.

03100.2.9 MOISTURE ABSORPTIVE COVER MAT

Shall be clean cotton or burlap fabric roll goods.

03100.2.10 CURING COMPOUND

Shall be a clear type with fugitive dye conforming to ASTM C-309, Type 1, unless otherwise approved by the ENGINEER. **CAUTION!!** The method of application of curing compound specified herein requires more product than is normally suggested by the manufacturer and that is customary in the trade. The amounts specified herein shall be applied, regardless of manufacturer's recommendation or customary practice.

03100.3 CONSTRUCTION REQUIREMENTS**03100.3.1 SITE CONDITIONS**

The CONTRACTOR shall examine the condition of the area on which forms are to be installed and conditions under which the work of this Section is to be performed and shall correct unsatisfactory conditions which would prevent proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

03100.3.2 DESIGN OF FORM-WORK

03100.3.2.1 **LOADING** - Form-work shall be designed to safely support all vertical and lateral loads that may be induced by wet concrete both during the placement and afterward, until such loads can be supported by the structure itself as the concrete sets and begins to cure. Forms and falsework shall be designed to include assumed values of live load, dead load, weight of moving equipment to be operated on form-work, concrete mix, height of concrete drop, vibrator frequency, ambient temperatures, foundation pressures, stresses, lateral stability and other factors pertinent to the safety of the structure during construction.

In form-work design, provide for all openings, offsets, keyways, recesses, moldings, reglets, chamfers, blocking, screed, bulkheads, anchorage, inserts and other features as required on the Drawings.

03100.3.2.2 **TOLERANCES** – Form-work design shall call out material and components of sufficient strength, thickness, number of ties, amount of bracing, etc., to withstand the pressure of newly placed concrete without bow or deflection.

03100.3.3 FORM-WORK CONSTRUCTION

03100.3.3.1 **COMPLIANCE** – Form-work shall be constructed in compliance with ACI 347, to the exact sizes, shapes, lines and dimensions shown, and as required to obtain accurate alignment, location, grade, and level and plumb work in finished structures.

03100.3.3.2 **MATERIALS** – Form-work shall be constructed from steel, steel reinforced panels, smooth grade plywood, or other materials which may be approved by the ENGINEER or shown on the Contract Documents for special purposes. Plywood material with raised grain, patches, or other defects that will mar the finished surface of the concrete surface shall not be used.

03100.3.3.3 **ERECTION** - Form facing materials shall be erected, supported, braced and maintained by structural members spaced to prevent deflection. Form-work shall be tight, to prevent leakage of cement paste during concrete placement. Joints shall be solidly butted together and backed up as required to prevent leakage and fins. Forms placed in successive units for continuous surfaces shall be fitted to provide accurate alignment, free from irregularities, and within allowable tolerances. Use selected materials to obtain required finishes.

Provide for all openings, offsets, keyways, recesses, moldings, reglets, chamfers, blocking, screed, bulkheads, anchorage, inserts and other features required. Accurately place and securely support items to be built into forms. Provide formed openings for elements to be embedded in or pass through the concrete. Install accessories in accordance with manufacturer's instructions and ensure items are not disturbed during concrete placement. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in the finished slab surface. Provide and secure units to support types of screeds required.

Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Bevel wood inserts for forming keyways, reglets, recesses and the like, to prevent swelling and assure ease of removal.

Form-work shall accommodate the work of all other trades where materials and products must be purchased and fabricated before the opportunity exists to verify the measurements of the adjacent construction affecting their installations. Verify size and location of all openings, recesses and chases with the trade requiring such items, and ensure that forms for openings and construction which accommodate installation by other trades, be accurately sized and located as dimensioned on the Drawings.

03100.3.3.4 FORM RELEASE AGENT - Coat form/concrete contact surfaces with form coating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

03100.3.3.5 CLEANING - Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt and other debris just before concrete is placed.

03100.3.3.6 TOLERANCES – The ENGINEER recognizes that, given the realities of the physical world, there are times when formwork for concrete cannot be constructed closely enough to yield zero tolerances in the finished work. Therefore, the following tolerances are allowed but shall not be exceeded:

- In general, deviation in alignment of slabs and walls shall not exceed ¼ inch in the horizontal or vertical dimensions of a pour. All slabs which are indicated to be level shall have a maximum deviation of 1/8 inch in 10 feet without any apparent change in grade.
- The maximum tolerance from true level and plumb throughout the entire length and/or height of a structure shall be +/- ¼ inch and without any abrupt changes from one part of the pour to another.
- Form-work construction for circular structures shall be allowed a maximum deviation in the arc of ¼ inch in each 10 feet of radius; therefore, as an example, a tank with a 50 foot radius shall be allowed a maximum deviation of 1-1/4 inch from the center of the tank to the arc of the wall. In circular construction, the CONTRACTOR also is allowed to deviate from the finish line shown on the Drawings through the use of form panels, which will give chord lengths not to exceed 2 feet.

In the event that deviation from the Drawing dimensions results in problems in the field, the CONTRACTOR shall be responsible for resolution of the conditions, as approved by the ENGINEER, without additional expense to the OWNER.

03100.3.4 REMOVAL OF FORMS

03100.3.4.1 CONSIDERATIONS ASSOCIATED WITH FORM REMOVAL - Forms shall be removed in a manner to insure complete safety of the structure. Forms shall not be removed until concrete has sufficient strength to carry its own weight and the loads upon it with safety. Do not pry against face of concrete; use only wooden wedges.

03100.3.4.2 MINIMUM ELAPSED TIME - Forms shall not be removed sooner than the minimum elapsed times given in the following schedule unless allowed otherwise in the Contract Documents or as directed by the ENGINEER.

When directed by the ENGINEER, because of weather conditions or for other reasons, the forms shall remain in place for longer periods than stated below. The periods of time for form removal set forth below are minimums with no allowances for external loading. The periods of time set forth below are permissive only and do not relieve the CONTRACTOR from responsibility for risks associated with form removal.

MINIMUM ELAPSED TIME

Structural Component	Over 50°F	Between 40° and 50°F
Walls and perimeter forms at slab on grade panels	2 days	3 days

Underside of slabs	10 days	14 days
Side forms of beams	2 days	3 days
Underside of beams	10 days	14 days
Stairways	10 days	14 days

The time periods shown above are based on concrete materials being mixed and placed in accordance with these Specifications. When high early strength inducing admixtures are used in concrete, the ENGINEER may permit form removal after shorter times than those shown in the table. Form removal time also may be reduced if test cylinders of concrete, field cured along with the concrete they represent, have reached the strength specified in Paragraph 03050.2.6.2 of Section 03050 – Portland Cement Concrete.

03100.3.4.3 RE-SHORING - Where no re-shoring is planned, leave forms and shoring used to support weight of concrete in beams, slabs and other concrete members in place until concrete has attained its specified strength. Where re-shoring is planned, supporting form-work may be removed when concrete has reached 70 percent of specified strength, provided re-shoring is installed immediately.

Place re-shores as soon as practical after stripping operations are complete, but in no case later than the end of the working day on which stripping occurs. During re-shoring, do not subject concrete in beam, slab, column or any other structural member to combined dead, construction, and live loads in excess of loads permitted for developed concrete strength at time of re-shoring. Tighten re-shores to carry required loads without over stressing.

Re-shores shall remain in place until the supported concrete has reached its specified strength.

03100.3.5 CONCRETE FINISHING

03100.3.5.1 FINISHING FORMED SURFACES - Within 72 hours after forms are removed, the CONTRACTOR shall finish exposed surfaces in accordance with one of the procedures described below. Where no finish requirement is provided on the Drawings, formed concrete surfaces exposed to view and surfaces designated to receive paint shall be given a "Smooth" finish and slabs shall be given a "Trowel" finish. When workmanship is less than the acceptable standard, provide one of the rubbed finishes at no additional cost to OWNER.

- F1 - As Cast Form Finish - No finish.
- F2 - Rough Finish - Patch defects and chip or rub off fins exceeding 0.33 inch height.
- F3 - Smooth Finish - In addition to the rough finish requirements, patch tie holes and defects and remove fins completely. When surface texture is impaired and form joints misaligned, grind, bush-hammer or correct such areas. Slurry grout areas evidencing minor mortar leakage to match adjacent concrete. Repair major mortar leakage as a defective area.
- F4 - Smooth Rubbed Finish - Remove forms and perform necessary patching as soon after placement as possible. Finish newly hardened concrete no later than 24 hours following form removal. Perform a smooth finish, then wet surfaces and rub with carborundum brick or other abrasive until uniform color and texture are produced.
- F5 - Grout Cleaned Rubbed Finish - Undertake this operation after all contiguous surfaces are completed and accessible. Perform a smooth finish, then brush blast with abrasive basting to open surface pores. Wet surface of concrete sufficiently to prevent absorption of water from grout. Mix grout in accordance with Section 03600 and rub a uniform coat over surface to be finished. Immediately after grouting, scrub surface with cork float or stone to coat surface

and fill voids. While grout is still plastic, remove excess grout by working surface with rubber float or sack. After surface whitens from drying, rub vigorously with clean burlap. Keep damp for at least 36 hours after final rubbing.

- F6 - Cork Floated Rubbed Finish - Remove forms within 2 to 3 days of placement where possible. Perform a smooth finish and then dampen wall surface. Mix mortar in accordance with Section 03600, and apply with firm rubber float or with trowel, filling all surface voids and compress mortar into voids. If mortar surface dries too rapidly to permit proper compaction and finishing, apply a small amount of water with fog sprayer. Produce a final texture with a cork float using a swirling motion.
- F7 - Unformed Finish - After concrete is placed, strike smooth, tops of walls or buttresses, horizontal offsets and similar unformed surface occurring adjacent to formed surfaces. Float to texture which is reasonably consistent with formed surface. Continue final treatment on formed surfaces uniformly across unformed surfaces.
- F8 - Blasted Finish - Complete a smooth finish then perform abrasive blasting within 24 to 72 hours after casting. Coordinate with form-work construction, concrete placement schedule and form-work removal to ensure that surfaces are blasted at the same age for uniform results. Reapply curing protection after blast finishing.
- F9 - Architectural Finish - Finish in accordance with ACI 303.
- F10 - Tooled Finish - Dress thoroughly cured concrete surface with electric, air or hand tools to uniform texture, and give a bush hammered surface texture. Remove sufficient mortar to exposed coarse aggregate in relief and to fracture coarse aggregate for tooled finish.

03100.3.5.2

REPAIRING FORMED CONCRETE SURFACES - When the Drawings indicate repairs are required or when the ENGINEER determines areas are defective and require repair, the following procedure shall be taken to make repairs:

- Remove defective concrete to sound concrete and make edges perpendicular to surface or slightly undercut. Feathered edges are not permitted.
- Dampen area to be patched and at least 6 inches surrounding it.
- Prepare bonding grout by mixing to consistency of thick cream and brush into surface.
- Tie holes shall be cleaned, thoroughly dampened, and filled solid with patching mortar.
- Make any patches in concrete to closely match color and texture of surrounding surfaces. Determine mix formula for patching mortar by trial to obtain a good color match with concrete when both patch and concrete are cured and dry.
- Mix white and gray Portland cement as required to match surrounding concrete to produce grout having consistency of thick paint. Use a minimum amount of mixing water.
- Mix patching mortar in advance and allow to stand, without addition of water, and without frequent manipulation, until it has reached a stiff consistency. After surface water has evaporated from patch area, brush bond coat into surface. When bond coat begins to lose water sheen, apply patching mortar. Thoroughly consolidate mortar into place and strike-off to leave patch slightly higher than surrounding surface. Leave undisturbed for at least 1 hour before final finish. Keep patched area damp for 72 hours or apply curing compound.

- Do not use metal tools in finishing an exposed patch.
- Where as cast finishes are indicated, total patched area may not exceed 1 in 500 of as cast surface. This is in addition to form tie patches, if ties are permitted to fall within as cast areas.
- In any finishing process which is intended to expose aggregate on surface, patched areas must show aggregate. Outer 1-inch of patch shall contain same aggregates as surrounding concrete. After curing, expose aggregates together with aggregates of adjoining surfaces by same process.

03100.3.5.3 FINISHING SLAB SURFACES - In no case shall water be added to the surface (i.e., by sprinkling) to finish. Slab surfaces shall receive one of the following finish treatments as indicated on the Drawings:

- S1 - Floated Finish - After concrete has been placed, consolidated, struck-off and leveled, do not work further until ready for floating. Begin floating when water sheen has disappeared and surface has stiffness sufficient to permit operation. During or after first floating, check plainness of entire surface with a 10 foot long straight edge applied at 2 or more different angles. Cut down high spots and fill low spots to the required tolerance. Re-float slab immediately to a uniform sandy texture.
- S2 - Trowel Finish - Float finish the surface. Power trowel or hand trowel as required to provide a uniform surface. Do not apply (i.e. sprinkle) water or dry cement to surface of concrete when finishing. First troweling after floating shall produce smooth surface relatively free of defects but may still show some trowel marks. Second trowel by hand after surface has hardened. Leave finished surface essentially free of trowel marks, uniform in texture and appearance. On surfaces intended to support floor coverings, grind off defects which would show through floor coverings.
- S3 - Broom Finish – Trowel finish the surface. Power trowel or hand trowel as required to provide uniform surface. Lightly brush surface parallel to direction of drainage with a hair broom. Coarseness of broom bristle may be varied slightly, to achieve desired degree of surface roughness.
- S4 - Exposed Aggregate Finish - Immediately after surface of concrete has been leveled to tolerance and surface water has dissipated, spread aggregate uniformly over surface to provide complete coverage to the depth of a single stone. Embed aggregate into surface by light tamping. Float surface until embedded aggregate is fully coated with mortar and surface has been brought to tolerance. Start exposure of aggregate after matrix has hardened sufficiently to prevent dislodgement. Flow ample quantities of water, without force, over surface of concrete while matrix encasing aggregate is removed by brushing with a fine bristle brush. Continue until aggregate is uniformly exposed. An approved chemical retarder sprayed onto freshly floated surface may be used to extend working time.
- S5 - Chemical Hardener Finish - Apply liquid chemical hardener finish to interior concrete floors where indicated. Do not apply liquid chemical concrete hardener on floor areas scheduled to receive synthetic matrice terrazzo, setting beds for tile, terrazzo, vinyl flooring or like items. Apply hardener after complete curing and drying of concrete surface in accordance with manufacturer's recommendations. Evenly apply each coat and allow 24 hours for drying between coats. After final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

03100.3.6 CONCRETE CURING

03100.3.6.1 SURFACES WITH UNREMOVED FORMS - When forms are left in place (i.e., underside of beams, etc.) the CONTRACTOR shall proceed with curing adjacent surfaces without regard to the formed surfaces. When such forms are removed, curing shall then proceed over the entire surface.

03100.3.6.2 CURING CONDITIONS - Immediately after finishing of concrete surfaces (formed or slab) the CONTRACTOR shall verify concrete surfaces are ready for curing. The CONTRACTOR shall correct any conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected. A minimum ambient temperature of not less than 40° shall be maintained for at least 7 days during concrete curing. Concrete shall then be cured by one of the following methods:

- Moisture Cover - Water or continuous water-fog spray shall be applied, or the concrete surface shall be covered with water saturated absorptive mat kept continuously soaked, for not less than 7 days and nights.
- Moisture Retaining Sheet - Place cover in widest practicable width with sides and ends lapped and sealed to prevent moisture loss for a period of not less than 7 days and nights. All holes or tears in the cover sheet shall be kept repaired during the curing period.
- Membrane Curing Compound – All required repairs, patching, and final finishing operations shall be completed prior to application. Curing compound shall be applied as soon as the concrete is firm enough to work on. Slab surfaces shall be coated with curing compound within one hour after form removal; if more than one hour has elapsed, the surface shall be water cured.

The compound shall be thoroughly mixed and a minimum of two coats shall be applied, with each coat applied in a direction different from that used for the preceding coat. The surface shall be coated and re-coated in a continuous operation until the surface has a uniform appearance; is effectively and completely sealed; and until a coating film remains on the surface of the concrete that can be scraped from the surface at any and all points after drying for at least 24 hours. Continuity of the coating shall be maintained, and all damage to the curing compound membrane shall be repaired, during the specified cure period.

Curing compound shall not be allowed within the silhouette of any construction joint. If any curing compound enters the construction joint, the joint shall be sandblasted prior to placing any new concrete.

Curing compound shall not be used on surfaces to be painted or coated.

Surfaces intended to contain potable water (tank interiors, etc.) shall not be cured with curing compounds.

Curing compound shall not be removed in less than 7 days from the time of application without written approval from the ENGINEER. When approved and prior to such removal, the CONTRACTOR shall provide a detailed plan for adequately curing the concrete.

03100.4 METHOD OF MEASUREMENT

Unless otherwise noted in the Special Provisions, separate measurement will not be made for concrete included as components of items shown in the Bid Schedule. Separate measurement for formed concrete and slabs shall be in accordance with the requirements of Section 03300.

03100.5 BASIS OF PAYMENT

Unless otherwise noted in the Special Provisions, no separate payment will be made for concrete included as components of items shown in the Bid Schedule. Separate payment for formed concrete and slabs shall be in accordance with the requirements of Section 03300.

03200.1 DESCRIPTION

Includes steel bars, wire fabric and rod mats required for cast-in-place concrete, with the necessary support chairs, bolsters, bar support and spacers required for supporting the reinforcement.

03200.1.1 RELATED Work

Section 03050 - Portland Cement Concrete
Section 03300 - Concrete Structures and Slabwork
Section 04810 - Unit Masonry Assemblies

03200.1.2 SUBMITTALS

03200.1.2.1 MILL TEST CERTIFICATION - Manufacturer's mill test certificates of supplied concrete reinforcement, indicating physical and chemical analysis shall be submitted.

03200.1.2.2 WELDER CERTIFICATION - Each welder's certification data shall be submitted to and approved by the ENGINEER prior to performance of welding on the project.

03200.1.2.3 SHOP DRAWINGS - Shop Drawings shall be submitted and shall indicate the sizes, spacings, locations and quantities of reinforcing steel and wire fabric; bending and cutting schedules; any proposed splicing; and reinforcement support, spacing devices and stirrup spacing.

03200.1.2.4 BAR SUPPORT SAMPLES - The CONTRACTOR shall submit for the ENGINEER's approval, samples of all bar supports it proposes to use along with a written description of where each type of bar support would be used.

03200.1.3 DEFINITIONS

Not used.

03200.2 MATERIALS

03200.2.1 CONCRETE REINFORCEMENT MATERIALS

03200.2.1.1 STEEL REINFORCEMENT - Unless otherwise specified, reinforcing steel shall be grade 60 billet steel conforming with ASTM A-615, including supplementary requirements S1. All such reinforcing shall be deformed steel bars with deformations in accordance with ASTM A-615. Bars shall be either uncoated or coated as indicated. ASTM A-706 steel shall be used if welding is indicated or allowed. All reinforcement shall be supplied in the maximum lengths practical or as indicated, unless otherwise authorized by the ENGINEER.

03200.2.1.2 WIRE FABRIC - Welded steel wire fabric shall be in accordance with ASTM A-1064 plain type. It shall be new stock and free of any rust when placed in the Work. Wire fabric may be supplied in flat sheets or coiled rolls and may be either coated or uncoated as indicated.

03200.2.1.3 STIRRUPS - Stirrup steel shall be in accordance with ASTM A-1064.

03200.2.1.4 SPIRAL REINFORCEMENT - Spiral reinforcement for columns or other components shall be cold drawn steel wire in accordance with ASTM A-1064.

- 03200.2.1.5 DOWEL BARS - Plain dowel bars for expansion joints shall be in accordance with ASTM A-615, 60-ksi-yield grade steel. Dowel bars shall be epoxy coated in roadway pavements. Metal dowel cans shall be provided at one end of dowel to permit longitudinal movement of the dowel within the concrete section. The CONTRACTOR shall provide for movement equal to the joint width plus 0.5-inch. Load transfer bars shall be painted with 1 coat of paint conforming to AASHTO M-254 and coated 1/2 with grease.
- 03200.2.2 ACCESSORY MATERIALS
- 03200.2.2.1 TIE WIRE - Tie wire shall be 16-gauge minimum cold drawn plain steel wire and shall be in accordance with ASTM A-1064.
- 03200.2.2.2 REINFORCEMENT SUPPORTS - Unless otherwise required in the Drawings or these Specifications, reinforcement supports bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place shall be wire type bar supports complying with CRSI recommendations. Wood, brick, and other unacceptable materials will not be allowed.
- 03200.2.2.3 SUPPORTS EXPOSED TO VIEW - Where support legs are in contact with forms on concrete surfaces exposed to view, supports shall be stainless steel or shall be provided with either hot-dip galvanized or plastic protected legs.
- 03200.2.3 FABRICATION
- 03200.2.3.1 STANDARDS - Steel reinforcement shall be cut, bent and fabricated in accordance with ACI SP-66 "ACI Detailing Manual" and with approved machine methods, in either the shop or the field.
- 03200.2.3.2 BENDING - Bars shall be accurately formed to the dimensions shown on the Drawings or applicable bending schedule. Bending or straightening in the shop or the field shall be accomplished so that the steel is not damaged. All bars shall be cold bent. Bends for hooks on bars shall be made around a pin having a diameter not less than 6 times the minimum thickness of the bar. Kinked bars shall not be used. Bars with bends not indicated on Drawings or final Shop Drawings shall not be placed in the Work. Reinforcement bars shall not be bent after they are embedded in concrete.
- 03200.2.3.3 SPLICES - Reinforcing splices not indicated on the Drawings shall be approved by the ENGINEER, and shall be located at points of minimum stress. The location of splices shall be indicated on Shop Drawings. Welding of reinforcing bars, when authorized by the ENGINEER, shall be performed in accordance with AWS D1.4. All rebar which is welded shall be grade 60 ASTM A706 material.

03200.3 CONSTRUCTION REQUIREMENTS**03200.3.1 DELIVERY AND STORAGE**

- 03200.3.1.1 DELIVERY - Deliver reinforcement to the job site bundled, tagged and marked. Use metal tags indicating bar size, lengths and other information corresponding to markings shown on placement diagrams.
- 03200.3.1.2 STORAGE - Take all means necessary to protect reinforcement materials before, during and after installation and to protect the installed work of other trades. Store all reinforcement materials in a manner to prevent excessive rusting and fouling with grease, dirt and other bond breaking coatings. Take all necessary precautions to maintain identification after bundles are broken. In the event of damage or errors, immediately make all repairs or replacements necessary and at no additional cost to the OWNER.

03200.3.2 REINFORCEMENT ERECTION

03200.3.2.1 CLEAN AND SOUND MATERIALS - At the time of placement in the Work, reinforcement shall be free of loose mill scale, loose or excessive rust, paint, oil or grease, or other coating which may destroy its bond with the concrete. Bars with reduced cross-section due to rusting or other cause, even if all rust has been removed, shall not be allowed in the Work.

03200.3.2.2 CLEARANCE - Maintain the distance from vertical forms and between layers of reinforcement by means of prefabricated chairs, ties, hangers or other approved devices in accordance with "reinforcement support" paragraphs below. Placement and fastening of reinforcement in each section of the Work must be approved before concrete is placed.

03200.3.2.3 CLEAR DISTANCE - The clear distance between parallel bars shall not be less than one and one-half times the diameter of the bars and shall in no case be less than 1 inch nor less than the maximum size of the coarse aggregate specified.

03200.3.2.4 MINIMUM COVER - Unless otherwise shown on the Drawings or approved by the ENGINEER, for all formed surfaces, the minimum concrete cover over the steel reinforcement shall be 1 1/2 inches for bars number 5 and smaller and 2 inches for bars number 6 through 18. The largest specified cover shall be used when different sized bars are encountered in the same face. No "bury" or "carrier" bars will be allowed unless specifically approved by the ENGINEER.

03200.3.2.5 CUTOUTS AND OPENINGS - Where reinforcing steel has to be cut to permit passage of pipe or to create openings with no detail available on the Drawings for extra reinforcement in such areas, the area of steel removed by the creation of the opening must be replaced by placement of at least double the area of the steel removed equally around the openings created. The steel shall be placed such that it extends 5 feet beyond the opening on each side, to provide for sufficient bond.

03200.3.2.6 METAL MESH - Sheets of metal mesh shall be bent as shown or required on the Drawings to fit the work. It shall be rolled or otherwise straightened to make a perfectly flat sheet before placement in the Work. Supports for metal mesh shall meet requirements for reinforcing bar supports.

Sheets of metal mesh shall be spliced in accordance with ACI 318 and shall be overlapped no less than 12 inches or one square plus 6 inches, whichever is greater, to maintain a uniform strength. The mesh shall be securely fastened at the ends, edges and at all supports to maintain clearances and overlaps.

03200.3.2.7 NOTICE TO OTHER TRADES - The CONTRACTOR shall ensure that all other crafts, sub-contractors, engineering support groups, etc., whose work is related to concrete placement, are provided with ample notice and opportunity to introduce and finish required embedded items before concrete placement. All sleeves, inserts, anchors and any other embedded items shall be located and set in place prior to concrete placement. All voids in embedded items shall be temporarily filled to prevent entry of concrete.

03200.3.3 SPLICING

03200.3.3.1 ENGINEER APPROVAL - Except as shown on the Drawings, reinforcing steel shall not be spliced at any location without specific written approval of the ENGINEER. Splices in adjacent bars shall be staggered as directed by the ENGINEER.

03200.3.3.2 LAP SPLICES - Unless shown otherwise on the Drawings, or approved by the ENGINEER, bars up to and including number 11 shall be lap spliced in accordance with ACI 318 and shall be fastened together with steel wire.

Unless shown otherwise on the Drawings, or approved by the ENGINEER, bars at a lap splice shall be in contact with each other, and in no case shall the lap be less than 40 diameters of the spliced bars.

Unless shown otherwise on the Drawings, or approved by the ENGINEER, where bars are to be lap spliced at joints in the concrete, all bars shall project from the concrete first placed for a minimum length equal to the lap splice length as indicated on the Drawings. All concrete or other deleterious coating shall be removed from dowels and other projecting bars by wire brushing or sand blasting before the bars are embedded in a subsequent concrete placement.

03200.3.3.3 WELDING - Reinforcing steel shall be welded only if shown on the Drawings or approved in writing by the ENGINEER. All welding of reinforcing steel shall comply with AWS D1.4.

03200.3.3.4 EXPANSION JOINTS - Reinforcement, or other embedded metal items bonded to the concrete, shall not be permitted to extend continuously through any expansion joint, with the exception of dowels in floors bonded on only one side of joint.

03200.3.4 REINFORCEMENT SUPPORT

03200.3.4.1 PLACEMENT - All reinforcement shall be supported and retained in place, true to indicated lines and grades, by the use of approved bar supports, sized to position the steel in the exact location required on the Drawings. Supports shall be spaced at intervals of not more than 5 feet on center in any direction, to prevent movement of the steel during concrete placement. Deck steel shall be tied down to beams or forms at regular intervals not exceeding 5 feet on center in any direction.

03200.3.4.2 CONCEALMENT - Supports shall be completely concealed in the concrete and shall not discolor or otherwise mar the surface of the concrete.

03200.3.4.3 SAND PLATES - Supports with sand plates or horizontal runners shall be used for slabs on grade where the base material will not support chair legs.

03200.3.5 QUALITY COMPLIANCE

Reinforcing materials found to be damaged or at variance with the requirements of the Drawings or these Specifications for size, quantity, strength, position, arrangement, or other attribute, shall result in rejection of the concrete Work if they are not brought into compliance.

03200.4 METHOD OF MEASUREMENT

03200.4.1 NO MEASUREMENT

Unless shown otherwise, concrete reinforcement shall be included with the concrete item within which it is installed and no separate measurement shall be made.

03200.4.2 SEPARATE MEASUREMENT

When shown as a separate item on the Bid Schedule, measurement of reinforcing steel will be, based on the theoretical or calculated number of pounds placed and accepted according to the requirements of the Drawings and these Specifications. Measurement shall exclude splice bars used to replace test samples. No deductions will be made for any bends except for hooks. The

length of the bar to be added to out-to-out dimensions of hooked bars will be shown on the plans. The weight calculations shall be based upon the following table:

WEIGHT CALCULATIONS FOR REINFORCING STEEL

Size	Lbs. per Lineal Foot	Size	Lbs. Per Lineal Foot
1/3 inch	0.167	#8	2.670
#3	0.376	#9	3.400
#4	0.668	#10	4.303
#5	1.043	#11	5.313
#6	1.502	#14	7.650
#7	2.044	#18	13.600

03200.5**BASIS OF PAYMENT**

The accepted quantities of reinforcing steel will be paid for at the contract unit price. No allowance will be made for clips, wires or other material used for fastening reinforcement in place.

Payment will be made under:

PAY ITEM	UNIT
Reinforcing Steel	Pound

03300.1 DESCRIPTION

Covers concrete placement operations for cast-in-place structural building frames, slabs and other components.

03300.1.1 RELATED WORK

Section 03050 - Portland Cement Concrete
Section 03100 - Concrete Forming, Finishing and Curing
Section 03200 - Concrete Reinforcement
Section 03310 - Concrete Joints for Slabwork
Section 03600 - Grout and Mortar

03300.1.2 SUBMITTALS

03300.1.2.1 RECORD OF PLACED CONCRETE - CONTRACTOR's record of placed concrete, which indicate the date, time, temperature, location, quantity, names/types of any additives used, and type of curing materials or procedures used.

03300.1.2.2 DELIVERY TICKETS - Copies of delivery tickets which indicate the date and time of delivery; the producer and the truck number; the volume of delivery; and the amounts (weights) of cement, aggregates and any additives, including all water added at plant and in the field.

03300.1.3 DEFINITIONS

Not used.

03300.2 MATERIALS**03300.2.1 CONCRETE**

Shall meet Class and material requirements of Section 03050.

03300.2.2 BONDING COMPOUND

Shall be polyvinyl acetate or acrylic base, single use type.

03300.2.3 VAPOR BARRIER

Shall be minimum 6 mil thick, polyethylene sheet, and the CONTRACTOR shall allow for 6 inch overlap at all edges, unless shown otherwise on Drawings. Vapor Barrier required for below grade application shall be free from pin holes, tears, scars and other defects.

03300.2.4 FORMS

Shall meet requirements of Section 03100.

03300.2.5 REINFORCEMENT

Shall meet requirements of Section 03200.

03300.2.6 COVERINGS AND CURING COMPOUND

Shall meet requirements of Section 03100.

03300.2.7 GROUT

Shall meet requirements of Section 03600.

03300.2.8 WATERSTOP

Waterstop shall be of the materials described and placed in the joints where shown on the Drawings and called for in these specifications. Precautions to insure proper support and location for the waterstop during concrete placement shall be taken.

03300.3 CONSTRUCTION REQUIREMENTS**03300.3.1 PREPARATION**

03300.3.1.1 ENGINEER NOTIFICATION - The ENGINEER shall be given not less than 24 hours notice of a pour before it starts.

03300.3.1.2 REINFORCEMENT AND OTHER MATERIALS - All anchors, seats, plates, reinforcement and other items, to be embedded or cast into concrete, shall be accurately placed, held securely, and not impede concrete placement.

03300.3.1.3 CONSTRUCTION LOADS - The CONTRACTOR shall ensure that construction loads shall not exceed member capacity.

03300.3.1.4 PREVIOUSLY PLACED CONCRETE - The CONTRACTOR shall prepare previously placed concrete by bush hammering or cleaning with steel brush, as required by the Drawings or these Specifications, and by application of the required bonding compound in accordance with manufacturer's instructions.

03300.3.1.5 DOWELING TO EXISTING WORK - At locations where new work is to be doweled to existing work, the CONTRACTOR shall drill 1 inch minimum oversize holes 20 bar diameters deep into the existing concrete. Holes shall be thoroughly cleaned with oil free air filled with epoxy grout from the bottom out, then insert the dowel full depth.

03300.3.1.6 TEMPERATURES - Temperature at the time of placement shall meet requirements provided in Section 03050 and Subsection 03300.3.4.1 below.

03300.3.1.7 DELIVERY - The CONTRACTOR shall ensure that concrete delivery meets all requirements of Section 03050.

03300.3.2 CONCRETE PLACEMENT

Concrete shall be conveyed, deposited and consolidated by methods that preclude separation or loss of ingredients.

03300.3.2.1 CONVEYING OF CONCRETE – Conveying of concrete shall be carried out as follows:

- Chutes for conveying concrete shall be sloped to permit concrete of the required consistency to flow without segregation.
- Where necessary, chutes shall be supplied with baffle boards or a reversed section at the outlet.
- Concrete shall not be allowed to drop more than 6 vertical feet without the assistance of pipes or tremies.

03300.3.2.2 DEPOSITION OF CONCRETE – Deposition of concrete shall adhere to the following requirements:

- Concrete shall not be placed if the subgrade is muddy, soft, or frozen.
- Concrete shall be deposited as near to its final position as practical.
- Use of vibrators for shifting concrete is not permitted.
- Concrete shall be placed in horizontal layers insofar as practical with placement starting at the low point and proceeding up grade.
- Concrete slabs or footings shall be placed on compacted soil surfaces and the subgrade shall have a dampened condition. To achieve the dampened condition, the subgrade may be sprinkled with water in advance of placing concrete.
- Concrete placement shall be continuous between construction joints and shall be terminated with square ends and level tops unless otherwise shown on the plans.
- Concrete shall not be placed in horizontal sections until the concrete in the adjoining vertical members has been consolidated and 2 hours has elapsed to allow for shrinkage.
- Where concrete is to be deposited against hardened concrete joints, placement shall not begin until a grout mixture has been coated on the joint. This grout mixture shall consist of mixture prescribed in Section 03600.

03300.3.2.3 CONSOLIDATION OF CONCRETE - Consolidation of concrete, except for slope paving and concrete placed underwater, shall be accomplished through the use of vibrators as follows:

- A sufficient number of spare vibrators shall be kept available to preclude interruption of concrete placement due to vibrator failure and to have the capacity to consolidate the concrete mass within 15 minutes after placement in the forms.
- The location, manner and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete without separation of the mortar and coarse aggregate, and without causing water or cement paste to flow to the surface.
- Vibrators shall be operated so as not to contact the subgrade, reinforcing steel or form work, and shall not be used to move the mass of concrete horizontally.
- External vibration, except for vibrating screeds, shall not be used, unless approved by the ENGINEER prior to the start of concrete placement.

03300.3.3 WATERSTOPS

Waterstops in the walls shall be carried into the slabs below and shall join the waterstops in the slabs with factory-made fittings or welded joints. All joints in water-bearing structures shall have waterstops, whether indicated on the plans or not. For other location requirements for waterstops, see the general notes of the plans.

03300.3.4 TIME LIMITATIONS

Mixed concrete shall be rejected if it is not placed within 90 minutes after water is introduced into the mixture and air temperature is 80°F or less, or if it is not placed within 60 minutes after water is introduced into the mixture and air temperature is above 80°F; or if the initial set has developed.

03300.3.5 HOT OR COLD WEATHER PLACEMENT REQUIREMENTS

03300.3.5.1 TEMPERATURE LIMITATIONS - Concrete temperature shall be between 50°F and 90°F at the time of placement in the forms.

03300.3.5.2 HOT WEATHER CONDITIONS - Hot weather conditions shall be considered to exist when ambient temperatures exceed 90⁰ F, or when the ambient temperature is below 90⁰ F but the temperature to humidity relationships shown in the following table for conditions below 90⁰ F exist.

TEMPERATURE/HUMIDITY RELATIONSHIP

Relative Humidity Less Than (Percent)	Air Temperature Greater Than (°F)	Maximum Concrete Temperature (°F)
80	90	90
70	90	90
60	90	90
50	90	85
40	90	80
30	80	75
20	75	70

During hot weather conditions, the CONTRACTOR shall take the following steps to protect the concrete:

- The concrete ingredients shall be cooled before mixing to maintain concrete temperature at time of placement below the maximum acceptable values listed in the table below.

Mixing water may be chilled or chopped ice may be used to control the concrete temperature, provided the water equivalent of the ice is calculated into the total amount of mixing water. Ice shall be completely melted and dispersed throughout the mix at the completion of the mixing time.

All methods and equipment for cooling of water and aggregate shall be subject to approval of the ENGINEER, and shall conform to ACI 305.1.

- Reinforcing steel shall be covered with water-soaked burlap as required, to prevent the steel temperature from exceeding the ambient air temperature immediately before concrete placement.
- Forms shall be thoroughly wet, but free of standing water, before concrete placement. Concrete should be placed in shallower layers than under normal weather conditions if necessary to assure coverage of the previous layer while it will respond readily to vibration.
- Fog spray shall be used during finishing whenever necessary to avoid surface plastic-shrinkage cracking. Fog spray shall also be used after finishing, before the specified curing is commenced, to avoid surface plastic-shrinkage cracking.

- Forms shall be kept covered and continuously moist. Once forms are loosened and during form removal, concrete surfaces shall be protected from drying, and shall be kept continuously wet by fog spraying or other approved means.

Additional costs due to concrete placement in hot weather conditions shall be the responsibility of the CONTRACTOR.

03300.3.5.3 COLD WEATHER CONDITIONS - Cold weather limitations shall apply when air temperature falls below 40°F. Procedures for protecting concrete shall be in accordance with ACI Standard 306.1, "Standard Specifications for Cold Weather Concreting." If concrete placement is necessary during low temperature conditions, the CONTRACTOR shall take the following steps to protect the concrete:

- The CONTRACTOR shall heat all water and aggregates uniformly in accordance with Section 03050 before mixing, to obtain a concrete mixture temperature between 60°F and 90°F at the time of placement.
- The CONTRACTOR shall not use calcium chloride, salt or other material containing antifreeze agents or chemical accelerators unless approved otherwise in writing by the ENGINEER.
- If temperatures are expected to drop below 32°F the night before the concrete is placed, all reinforcement, the forms, and the ground shall be blanketed. If the temperature falls below 20°F, the area shall be preheated at a minimum temperature of 40°F for a minimum of 12 hours prior to placement.
- The concrete shall be protected from freezing. The CONTRACTOR shall furnish all materials and equipment to insulate and to heat the work as necessary to maintain concrete temperatures above 50°F.
- Concrete temperature shall be maintained at not less than 50°F and not more than 70°F for the first 7 days after placement.
- Combustion type heaters, which produce carbon monoxide (CO), shall be adequately vented.

The CONTRACTOR shall assume all risk in connection with placing concrete in cold weather conditions. Permission given to place concrete in cold weather shall in no way relieve the CONTRACTOR of the responsibility for compliance with these Specifications. Any work not in compliance with these Specifications due to cold weather conditions shall be removed and replaced at the CONTRACTOR's expense.

03300.3.6 JOINTS

03300.3.6.1 COMPLIANCE - Construction joints shall be placed at the locations shown on the Drawings or as approved by the ENGINEER. Expansion and contraction joints and joint sealing shall be accomplished in accordance with Section 03310.

03300.3.6.2 CLEANING - Unless otherwise directed by the ENGINEER, all construction joints shall be cleaned prior to placement of concrete. All unsatisfactory concrete, latency material, stains, debris, and other foreign materials shall be removed. After cleaning, the surface shall be washed thoroughly to remove all loose material. Excess water shall be disposed of in such manner that it will not stain, discolor, or otherwise affect adjacent surfaces of the structures.

03300.3.7 FINISHING

Finishing shall be accomplished as indicated on the Drawings and in accordance with the requirements of Section 03100. Water shall not be sprinkled on concrete surfaces during finishing.

03300.3.8 CURING

Curing shall meet the requirements of Section 03100.

03300.3.9 PROTECTION

The CONTRACTOR shall provide necessary barriers, walkways, etc. to protect freshly placed concrete from physical damage. Any damage sustained as a result of failure to provide such protection shall be corrected at the CONTRACTOR's expense.

03300.3.10 REPAIR OF DEFECTIVE CONCRETE

03300.3.10.1 REPAIR FOR NON-COMPLIANCE - All concrete that fails to conform to required material characteristics, dimensions, lines, finishes and elevations shown on the Drawings, or in accordance with these Specifications shall be replaced or corrected in accordance with these Specifications and as approved by the ENGINEER.

03300.3.10.2 ADDITIONAL TESTING - Any engineering analysis and additional testing required to determine the extent of repair will be provided by the CONTRACTOR at no additional cost to the OWNER.

03300.3.10.3 REMOVAL OF SLABS WITH CRACKS - Removal of concrete sections with cracks in slabs which occur within 2 feet of expansion or construction joints may be deemed necessary by the ENGINEER.

03300.3.11 QUALITY COMPLIANCE

Concrete work may be rejected for failure to comply with the following requirements:

03300.3.11.1 SPECIFICATION NON-COMPLIANCE - Concrete work shall be rejected if the materials used in the work fail to comply with the requirements of Section 03050 and 03200.

03300.3.11.2 STRENGTH TEST FAILURE - Concrete work, for which the average of three 28-day compressive or flexural strength samples made from the same batch falls below the acceptance level, per ACI 301 and 318, shall be rejected, unless otherwise directed by the ENGINEER.

03300.3.11.3 IMPROPER CURING - Concrete work for which the method of curing is not as specified, or that has been inadequately protected from extremes of temperature during the early stages of hardening and strength development, shall be rejected, unless otherwise directed by the ENGINEER.

03300.3.11.4 ACCIDENT AND INJURY - Concrete work that has been subjected to construction fires, accidents, mechanical injury or premature removal of formwork likely to result in deficient strength development, shall be rejected, unless otherwise directed by the ENGINEER.

03300.3.11.5 POOR WORKMANSHIP - Concrete work, subjected to poor workmanship that may result in deficient strength or load carrying capacity, including but not limited to honey combing, cold joints, introduction of contaminants or embedded debris, improper placement location or dimensions, etc., shall be rejected, unless otherwise directed by the ENGINEER.

03300.3.11.6 POOR FINISH - Concrete work that fails to meet the required finish in accordance with the requirements of Section 03100, or exposed concrete with defects adversely affecting the appearance of the specified finish shall be rejected, unless otherwise directed by the ENGINEER.

03300.4 METHOD OF MEASUREMENT

03300.4.1 NO MEASUREMENT

When concrete is not indicated as a separate item in the Bid Schedule, no measurement will be made and the concrete required for a structure shall be considered a component of another item or items shown in the Bid Schedule.

03300.4.2 SEPARATE MEASUREMENT

03300.4.2.1 CUBIC YARD - When concrete is indicated as a separate item on the Bid Schedule, measurement shall be made by counting the number of cubic yards placed and accepted as determined by calculating volumes using the dimensions shown on the Drawings. This measurement shall NOT include:

- Any allowance for reinforcing steel in concrete.
- Any allowance for concrete required for filling over-excavation for footings, walls or slabs.
- Any allowance for volume occupied by pipes (except culverts), reinforcing steel, anchors, conduits, or weep holes.

03300.4.2.2 SQUARE UNIT – Measurement for square feet or yards of concrete shall be made using an accurate measuring device to determine the length and breadth of concrete placed and accepted and then multiplying those values to find the amount of area covered.

03300.5 BASIS OF PAYMENT

The accepted quantities shall be paid for at the contract unit price:

PAY ITEM	UNIT
Concrete (<i>Class _____</i>)	Cubic Yard
Concrete (<i>Class _____</i>)	Square Yard
Concrete (<i>Class _____</i>)	Square Foot
Concrete Structure (<i>Name</i>)	Lump Sum

SPECIAL PROVISION

CONCRETE STRUCTURES AND SLABWORK

**SECTION
SP 03300**

Add the following sections:

03300.4 METHOD OF MEASUREMENT

03300.2.3 LINEAR FOOT – Concrete shall be measured by the linear foot for curb and gutter and sidewalk. The linear foot measurement shall include all work and materials required for installation as specified in the contract documents. This includes, forming, pouring, finishing, concrete material, and untreated base course, etc. pertaining to the linear foot item.

03300.2.4 EACH – An each measurement will be used for the installation of ADA ramps, concrete driveways, concrete driveway entrances, and concrete backup pads . The measurement shall include all work and materials to install the item per the details in the contract documents. This includes all equipment, concrete, rebar, earthwork, untreated base course, truncated domes, forming, pouring finishing, transportation, etc.,.

03300.5 BASIS OF PAYMENT

The accepted quantities shall be paid for at the contract unit price:

PAYMENT ITEM	UNIT
Curb and Gutter	LINEAL FOOT
(Width') Sidewalk	LINEAL FOOT
Pedestrian Refuge	EACH
ADA Ramp	EACH
Concrete Driveway Entrance	EACH
Precast Culvert Section	EACH
Concrete Generator Pad	LUMP SUM
Concrete Air Gap Box	LUMP SUM

03310.1 DESCRIPTION

Furnish materials and install appropriate longitudinal and transverse expansion joints, construction joints and crack control joints in slabs and pavement.

03310.1.1 RELATED WORK

Section 03050 - Portland Cement Concrete
Section 03100 - Concrete Forming, Finishing, and Curing
Section 03300 - Concrete Structures and Slabwork

03310.1.2 SUBMITTALS

The CONTRACTOR shall submit the following to the ENGINEER for review and approval:

03310.1.2.1 PRODUCT CERTIFICATION – The manufacturer's certification that product was manufactured, tested and supplied in accordance with source control requirements specified herein, together with a report of the test results and the date each test was completed.

03310.1.2.2 INSTRUCTIONS – The manufacturer's instructions for joint preparation, type of cleaning and installation.

03310.1.2.3 DATA SHEETS – The manufacturer's product and safety data for each joint sealant product required.

03310.1.2.4 SAMPLES – A manufacturer's sample of each joint sealant product required.

03310.1.3 DEFINITIONS

Not used.

03310.2 MATERIALS**03310.2.1 GENERAL**

03310.2.1.1 COMPATIBILITY OF MATERIALS - Provide joint filler, sealant backings, sealants 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.

03310.2.1.2 DELIVERY OF MATERIALS - Deliver materials to site in original unopened containers or bundles with labels identifying manufacturer, product name and designation, color, expiration period for use, pot life, cure time and mixing instructions for multi-component materials.

03310.2.1.3 STORAGE AND HANDLING OF MATERIALS - Store and handle materials in compliance with manufacturer's recommendations to prevent deterioration; or damage due to moisture, high or low temperatures, contaminants or other causes.

03310.2.2 PRODUCTS

03310.2.2.1 JOINT VOID FORMER - Shall be of plastic with a waterstop and shall extend 1/3 of the depth of the concrete structural section.

03310.2.2.2 JOINT FILLER - J4 joint filler shall be the required standard and shall be used unless another filler from the list below is specified. Fillers shall be non-extruding, resilient, and meet the requirements of ASTM D-545:

- F1 Joint Filler – 13mm thick filler for expansion joints; bituminous (asphalt or tar) mastic in accordance with ASTM D-994; formed and encased between 3 layers of bituminous saturated felt or 2 layers of glass fiber felt.
- F2 Joint Filler - Cane or other cellulosic fiber in accordance with ASTM D-1751, saturated with asphalt.
- F3 Joint Filler - Granulated cork in accordance with ASTM D-1751; in an asphalt binder; encased between 2 layers of asphalt saturated felt or 2 layers of glass fiber felt.
- F4 Joint Filler - Sponge rubber fully compressible in accordance with ASTM C-1752, with resiliency recovery rate of 90 percent minimum.
- F5 Joint Filler - Cork in accordance with ASTM C-1752; impregnated and bound with asphalt; compressible with resiliency recovery rate of 90 percent if not compressed more than 50 percent of original thickness.
- F6 Joint Filler - Plastic foam (for cold-applied sealants only) pre-formed, compressible, resilient, non-waxing, non-extruding strips of flexible, non-gassing plastic foam; non-absorbent to water and gas; 20 lb/ft³ density maximum; and of size and shape to control sealant depth and performance.
- Synthetic Sponge Rubber Filler - Synthetic sponge rubber filler shall be an expanded closed cell sponge rubber, manufactured from a synthetic polymer neoprene base. The material shall be No. 750.3 Ropax Rod Stock as manufactured by the Presstite Division of Interchemical Corporation; Bondtex as manufactured by Rubatex Corporation; or approved equal. The size of the material shall be 25 percent greater in diameter than the nominal joint width. The manufacturer's instructions for surface preparation and application shall be used as a guide for installation, except that the material shall not be installed by stretching beyond its normal length.

03310.2.2.3 SEALANT - Hot applied joint sealant shall be one of the following:

- HAS1 Sealant - Resilient and adhesive compound type in accordance with ASTM D-3405, for Portland cement concrete or asphalt concrete pavements.
- HAS2 Sealant - Thermoplastic type in accordance with ASTM D-3581, jet fuel resistant without rubber, unless indicated otherwise.
- HAS3 Sealant - Elastomeric type in accordance with ASTM D-1190.
- HAS4 Sealant - Elastomeric type in accordance with ASTM D-3406, one component, for Portland cement concrete pavements.
- HAS5 Sealant - Elastomeric type in accordance with ASTM D-3569, one component, jet-fuel resistant, for Portland cement concrete pavements.

Cold applied joint sealant shall be one of the following:

- CAS1 Sealant - Elastomeric type in accordance with ASTM C-920; chemically curing, for vehicular or pedestrian use and types of construction other than highway and airfield pavements and bridges and joint substrates indicated; Type S or M; Grade P or NS; Class 25; Use T, NT, M and O with the following characteristics:
 - ⇒ Self leveling
 - ⇒ 40 ± 5 ASTM D-2240 Shore A Hardness
 - ⇒ 4 days minimum final cure
 - ⇒ 10 to +150⁰ F service range
- CAS2 Sealant - Mastic type in accordance with ASTM D-1850, single or multiple companion, for joints having a minimum width of 1/2 inch.
- CAS3 Sealant - Coal tar modified urethane type in accordance with FS SS-S-200; one part, jet fuel resistant; Type H.
- CAS4 Sealant – Elastomeric, pre-formed polychloroprene type with lubricant adhesive and indicated movement ratio which meets one of the following:
 - ⇒ For concrete pavement seal; ASTM D-2628
 - ⇒ For concrete bridge seal; ASTM D-3542

Synthetic rubber sealant shall be as follows:

- The sealant shall be a 3-part polyurethane compound.
- Sealant shall be designed to cure at room temperature to a firm, highly resilient rubber.
- Sealant shall have the following properties determined at conditions of 75° F and 50 percent relative humidity:
 - ⇒ Base - polyurethane rubber
 - ⇒ Solids - not less than 97 percent
 - ⇒ Application time - not less than 3 hours
 - ⇒ Cure time - not more than 5 days
 - ⇒ Ultimate hardness - 35 ± 5 (Shore A Durometer)
 - ⇒ Tensile strength (ASTM D412) - 300 pounds per square inch minimum
 - ⇒ Ultimate elongation - not less than 300 percent
 - ⇒ Color - gray to match concrete unless otherwise indicated
- All packages shall be code dated. No material shall be more than 6 months old when used. Material shall have been kept at temperatures lower than 80° F at all times.

03310.2.2.4 **BACKER ROD** – Backer rod shall be neoprene, butyl, EPDM, or silicone tubing complying with ASTM D-1056, water and gasoline non-absorbent, capable of remaining resilient at temperatures down to -26°F. Provide product with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.

03310.2.2.5 **BOND BREAKER TAPE** – Bond breaker tape shall be self-adhesive polyethylene or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to joint filler materials or joint surfaces at back or bottom of joint.

03310.2.2.6 WATERSTOPS - Waterstop shall be rubber waterstop or PVC waterstop as designated on the Plans or in the Special Provisions and shall meet the requirements described herein.

- Waterstops shall be as manufactured by Burke Concrete Accessories Inc., Kirkhill Rubber Company, Williams Products Inc., Greenstreak, or approved equal:
- Waterstop shall be of the width and cross-section configuration shown on the Drawings or required in the Special Provisions.
- At expansion joints, only hollow centerbulb type waterstop shall be used.

Rubber waterstop shall meet the following requirements and conditions:

- Waterstop shall be manufactured to ensure an integral cross section which will be dense, homogeneous, and free from porosity and other imperfections.
- Minor surface defects, such as surface peel, covering less than 1 square inch and surface cavities or bumps less than 1/4” in longest lateral dimension and less than 1/16” deep, will be acceptable.
- The rubber waterstop shall meet the following Specifications:
 - ⇒ Hardness-Shore A Durometer – 60 to 70, ASTM D 2240
 - ⇒ Elongation - not less than 450%
 - ⇒ Tensile Strength - not less than 3,000 psi
 - ⇒ Tensile Strength after aging 48 hours in oxygen at 70°C and 300 psi - not less than 80% of original
 - ⇒ 300% Modulus - not less than 900 psi
 - ⇒ Water absorption after 2 days at 158°F – not more than 5%
 - ⇒ Compression set after 22 hours at 158°F - not more than 30%
 - ⇒ Specific Gravity - 1.17 ± .03

Polyvinylchloride (PVC) waterstop shall be as manufactured by Greenstreak, or approved equal, and shall meet the following requirements and standards:

<u>Property</u>	<u>ASTM Test</u>	<u>Nominal Value</u>
⇒ Water absorption	D 570	0.15
⇒ Tear resistance	D 624	350/lb.in.
⇒ Ultimate elongation	D 638	390%
⇒ Tensile strength	D 638	2250 psi min.
⇒ Low temperature brittleness	D 746	+35°F/+37°C (passed at)
⇒ Stiffness in flexure	D 747	1190 psi
⇒ Specific gravity	D 792	1.37
⇒ Ozone resistance	D 1149	No failure
⇒ Volatile loss	D 1203	0.30%
⇒ Hardness (Shore A15)	D 2240	76+3
⇒ Accelerated Extraction		
Tensile strength		2130 psi
Elongation		370%

PVC waterstop shall be heat weldable, have great inherent elasticity, be impervious to many waterborne chemicals, be suitable for above or below grade installation, not produce electrolytic reactions, and not discolor concrete or mortar.

See Subsection 03310.3.4 for waterstop installation specifications.

03310.3 CONSTRUCTION REQUIREMENTS**03310.3.1 WEATHER CONDITIONS**

Do not proceed with installation of joint sealant under unfavorable weather conditions. Install elastomeric sealant only when temperature is stable within the temperature range recommended by manufacturer for installation.

03310.3.2 PREPARATION**03310.3.2.1 JOINT CLEANING** - Clean, prepare and size joints in accordance with manufacturer's instructions. Remove any loose materials and other foreign matter. Do not proceed with installation of joint sealant until contaminants capable of interfering with sealant adhesive properties are removed from joint substrates. Remove any moisture on the substrate.

Remove protective coating and any oil from metals with solvent recommended by the sealant manufacturer.

03310.3.2.2 JOINT DIMENSIONS - Examine joint dimensions and size materials to achieve required width to depth ratio. Adjust joint depths to allow sealant to perform properly.**03310.3.2.3 MATERIAL COMPATIBILITY** - Verify that joint shaping materials and release tapes are compatible with sealant.**03310.3.3 CONSTRUCTION****03310.3.3.1 FEATURES AND PURPOSES OF JOINT CONSTRUCTION** - Construct all joints as follows:

- At right angles to top surface of placement.
- Straight unless indicated otherwise.
- Before uncontrolled shrinkage cracking takes place.
- To prevent concrete edge slump.

03310.3.3.2 BOND BREAKER TAPE - Install where needed or required by manufacturer's recommendations to ensure that elastomeric sealant will perform properly.**03310.3.3.3 EXPANSION JOINTS** - Expansion joints shall be constructed as follows:

- They shall be placed in locations as shown on the Drawings or as approved by the ENGINEER.
- Joints in exterior concrete slab work shall be placed where shown on Drawings or as recommended by Portland Cement Association's "Design and Control of Concrete Mixture Manual".

- Pre-molded filler strips shall extend full depth in slab.
- Unless otherwise noted on the Drawings or directed by the ENGINEER, isolation joints shall be used in all areas where slabs abut vertical surfaces. Joint material shall be placed as called for and in good alignment.
- In no case shall the reinforcing or other fixed metal items embedded in or bonded to concrete be made to run continuously through an expansion joint.
- Concrete edges at joints shall be neatly finished with an edging tool providing a slightly rounded edge on each side of the joint filler material.

03310.3.3.4 CONSTRUCTION JOINTS - Other references to construction joints are located in Subsection 03300.3.6.

03310.3.3.5 CONTROL JOINTS – Control joints shall be constructed as follows:

- **Tooled Joints.** Tooled joints shall be formed by scoring the slab full depth with a steel trowel along a straight edge in locations as shown on the Drawings or, if not shown, not to exceed 625 square feet in area. The joint shall be finished using a joint tool guided by a straight edge leaving a slightly rounded edge on each side of the joint.
- **Sawn Joints.** Sawn joints shall be sawn into interior concrete floors as indicated on the Drawings and at CONTRACTOR's option in place of pre-formed metal keys. Joints shall be sawn with a power saw designed to saw depth and width as shown on Drawings. Hand held saws will not be accepted. Saw cutting shall occur within 12 hours after placement of concrete. The line of the saw shall be straight, true to line and square. Pourable joint sealant shall be poured into all sawn joints. Installation shall be in strict accordance with manufacturer's specifications which shall include preparation, priming, etc.

03310.3.3.6 JOINT SEALING - Installation of joint sealant shall adhere to the following procedures:

- Manufacturer's Instructions. Application shall be in strict accordance with the manufacturer's published instructions.
- Surface Preparation. All surfaces to which synthetic rubber sealant must bond shall be dry and free of dust, dirt, and other foreign residue and shall be primed with the manufacturer's recommended primer for the particular surface. Remove all oil, grease, wax, form release agents, curing compounds, bitumen, old caulking, and other latent material by sand blast or water blast, as recommended by the sealant manufacturer. Maximum angle for sand blasting is 25 degrees \pm 5. Clean and dry with air blast. Do not contaminate air blast with oils or lubricants. Remove frost and moisture in concrete joint substrates before commencing sealing.
- Installation. If necessary, joints shall be saw cut, to provide the required sealant thickness and depth. Application shall be by means of a pneumatic caulking tool or other approved method. Ensure that sealant is installed in uniform, continuous ribbons without gaps or air pockets, with complete bonding of joint surfaces on opposite sides. Except as otherwise indicated, fill sealant rabbet flush with surface. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove so that joint will not trap moisture and dirt.

Install sealant to depths indicated or, if not indicated, as recommended by sealant manufacturer, but within the following general limitations measured at center (thin) section of bead:

- ⇒ For sidewalks, pavements and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but neither more than 5/8 inch deep nor less than 3/8 inch deep.
- ⇒ For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2 inch deep nor less than 1/3 inch deep.
- ⇒ For joints sealed with non-elastomeric sealants and caulking compounds, fill joints to a depth in the range of 75 percent to 125 percent of joint width.

- Overflow and Spillage. Do not allow poured sealant compound to overflow or spill onto adjoining surfaces or to migrate into voids of adjoining surfaces. Clean adjoining surfaces to eliminate evidence of spillage.
- Overheating. Do not overheat hot applied sealants.
- Exposed Edges. Unless indicated otherwise, recess exposed edges of gasket and exposed joint filler slightly behind adjoining surface so compressed units will not protrude from joints.

03310.3.3.7 CURING AND PROTECTION – The CONTRACTOR shall follow the steps listed below regarding curing and protection of sealant:

- Cure sealant and caulking compounds in accordance with manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength and surface durability.
- Follow procedures required for cure and protection of joint sealants during construction period so they will be without deterioration or damage (other than normal wear and weathering) at time of Substantial Completion.
- Protect joint sealant during and after curing period from contact with contaminating substances, or from damage resulting from deterioration through the time of Substantial Completion.
- If damage or deterioration occurs, immediately cut out and remove damaged or deteriorated joint sealant and reseal joint with new materials. Repaired area shall be indistinguishable from un-repaired area.

03310.3.3.8 CLEANUP - Clean off all excess sealant or sealant smears adjacent to joints as the work progresses. Use methods and cleaning materials approved by manufacturers of joint sealant and of the products in which joints occur.

03310.3.4 WATERSTOPS

03310.3.4.1 INSTALLATION - Waterstops shall be installed in concrete joints where and as indicated on the Plans. Waterstops shall be set accurately to the position and line indicated on the Plans. Where required at expansion joints, the hollow, centerbulb type waterstop shall be installed centered on the joint.

03310.3.4.2 CONTINUITY - All waterstops shall be continuous. Waterstops in walls shall be carried into lower slabs and shall join the waterstops in the slabs with appropriate types of fittings. Waterstops shall be terminated 3 inches from the top of finished surfaces of walls and edges of slabs unless otherwise specified or indicated on the Plans.

03310.3.4.3 FASTENING IN PLACE - Edges shall be held and securely fixed in position at intervals of not more than 24 inches to prevent movement during the placing of the concrete. Wires placed near the outer bulb and/or special clips may be used for this purpose, at the CONTRACTOR's option. No nails shall be driven through a waterstop in the vicinity of any construction joint.

03310.3.4.4 JOINTS – Waterstop joints shall meet the following requirements

- All waterstop joints shall be watertight.
- All joints shall be made by the use of factory-made fittings and unions, some of which will be special.
- Fittings and unions shall be cemented in place using clamps over the entire area of splice until the cement is bonded permanently.
- Welding of the waterstop without the use of factory-made unions and fittings will not be permitted.
- Split type waterstop may be used, at the option of the CONTRACTOR, provided that all junctions between standard solid type waterstop and split type waterstop shall be made with solidly welded and cemented unions between the two waterstops. This union may be split and re-cemented in accordance with the manufacturer's recommended method.
- Cement shall be as recommended by the manufacturer of the waterstop, and field cementing or solvent welding shall be in accordance with the manufacturer's directions.

03310.4 METHOD OF MEASUREMENT

Unless otherwise indicated in these Specifications, no separate measurement will be made for the materials and work covered by this section.

03310.5 BASIS OF PAYMENT

Unless otherwise noted in these Specifications, no separate payment will be made for items under this section. Compensation shall be included in the prices paid for the various contract items and no separate compensation will be allowed.

03500.1 DESCRIPTION

This is a generic specification covering furnishing and installing of pre-cast concrete units, complete with required accessories as shown on the Drawings and called out in these Specifications.

03500.1.1 RELATED WORK

Section 01300 - Submittals
Section 02224 - Sewer Pipe and Manholes
Section 03050 - Portland Cement Concrete

03500.1.2 SUBMITTALS

03500.1.2.1 SHOP DRAWINGS - Submit shop drawings showing unit design, signed and sealed by a Professional ENGINEER, in accordance with Section 01300. The CONTRACTOR shall not proceed with fabrication until shop drawings have been approved.

03500.1.2.2 UNIT DESIGN – Unit design shall incorporate the following:

- Pre-cast units shall be designed in accordance with ACI 318 and PCA design handbooks under the direction of a Professional ENGINEER experienced in the design of such units.
- Indicate unit locations, unit identification marks, fabrication details, reinforcement, connection details, pertinent dimensions, and erection support points.
- Units shall be designed to support the required shipping and handling loads, and the live, dead and construction loads.
- Component connections shall be designed to provide adjustment to accommodate misalignment of structure during installation.
- The ENGINEER may approve design deviations provided that equivalent units serving the same basic function and intent are furnished at no additional cost to the OWNER. Such deviations shall only be approved upon written request and when accompanied with complete design calculations and drawings.

03500.1.3 DEFINITIONS

Not used.

03500.2 MATERIALS**03500.2.1 ACCESSORIES**

Connecting and supporting devices shall be carbon steel in accordance with ASTM A 36. Bolts, nuts and washers shall be carbon steel or stainless steel as required on the Drawings. Grade 60 reinforcement shall be provided for all units.

03500.2.2 IDENTIFICATION MARKS

Unit identification marks shall appear on all manufactured units.

03500.2.3 FINISHES

Shall be in accordance with one of the following paragraphs. If no finish is prescribed on the Drawings, the Standard Finish will be provided.

03500.2.3.1 STANDARD FINISH - Produced in plastic or metal lined forms which impart a smooth finish. Small surface holes, normal form joint marks, minor chips and spalls may be approved. Major or unsightly imperfections, honeycomb or structural defects are not acceptable.

03500.2.3.2 COMMERCIAL FINISH - Produced in plastic or metal lined forms which impart a smooth finish. Remove fins and large projections and fill holes over 1/2 inch with sand-cement paste. Faces shall be true and well defined. Exposed ragged edges shall be corrected by rubbing or grinding.

03500.2.3.3 ARCHITECTURAL GRADE FINISH - Produced in plastic or metal lined forms which impart a smooth finish. Fill holes over 1/4 inch in diameter with sand-cement paste. Grind smooth form offsets or fins over 1/8 inch. Coat with neat cement paste using a float and after paste has dried, rub with burlap to remove loose particles.

03500.2.3.4 SPECIAL FINISHES - Finishes produced by sandblasting, acid washing, or form liners shall be specifically defined on the Drawings or in these Specifications and samples showing texture and color will be required for approval.

03500.2.3.5 PAINTABLE FINISHES - Where unit surfaces will be painted, only form release agents compatible with paints shall be used during fabrication.

03500.3 CONSTRUCTION REQUIREMENTS**03500.3.1 FABRICATION**

Fabrication of pre-cast units shall proceed as follows:

03500.3.1.1 RECORDS - Maintain plant records and quality control program during production of structural pre-cast concrete. Make records available to ENGINEER.

03500.3.1.2 MOLDS - Use molds which are rigid and constructed of material that will result in uniform finished products.

03500.3.1.3 PLACEMENT AND VIBRATION - Place and vibrate concrete to ensure: proper consolidation, elimination of cold joints, and minimize entrapped air marks on finished surfaces.

03500.3.1.4 REINFORCEMENT AND FITTINGS - Provide required connecting devices, plates, angles, and connectors to steel framing members, bolts and accessories. Ensure reinforcing steel, anchors, inserts, plates, angles and other cast-in items are sufficiently embedded, anchored and properly located.

03500.3.1.5 LIFTING DEVICES - Embedded lifting or handling devices shall be capable of supporting units in positions anticipated during manufacture, storage, transportation and erection.

03500.3.1.6 FINISHED SURFACE - Ensure finished surfaces of pre-cast structural units are uniform.

03500.3.1.7 CURING - Cure units under identical conditions to develop specified concrete quality and minimize appearance of blemishes such as non-uniformity, staining or surface cracking.

03500.3.2 DELIVERY, STORAGE AND HANDLING

03500.3.2.1 DELIVERY - Unless otherwise approved in writing, do not deliver units to job site until required for installation.

03500.3.2.2 EDGE PROTECTION - Provide edges of units with adequate protection to prevent staining, chipping or spalling of concrete.

03500.3.2.3 HANDLING - Handle pre-cast units in positions consistent with their shape and design. Lift and support only from support points indicated on Shop Drawings.

03500.3.2.4 BLOCKING AND BRACING - Block and laterally brace units while in storage. Provide lateral bracing that is sufficient to prevent bowing and warping. Bracing shall be clean, non-staining and of a type that will not inhibit uniform curing of exposed surfaces.

03500.3.3 INSTALLATION

Do not install pre-cast units until concrete has attained its design compression strength. Install members plumb, level and in alignment. Clean weld marks or other marks, debris or dirt from exposed surfaces of units.

03500.3.4 REPAIR

Repair of damaged units may be acceptable if structural integrity or appearance is not impaired.

03500.4 METHOD OF MEASUREMENT

03500.4.1 NO MEASUREMENT

Separate measurement for pre-cast concrete units will not be made when the unit is a component of a building, assembly or enclosure for which identification is made in the Bid Schedule.

03500.4.2 SEPARATE MEASUREMENT

When pre-cast concrete units appear as a separate item on the Bid Schedule, they will be measured either by counting the number of units installed and accepted or by using a measuring tape or other accurate measuring device to determine the total number of lineal feet of units installed and accepted.

03500.5 BASIS OF PAYMENT

Separate payment for pre-cast concrete units will not be made when they are a component of building, assembly or enclosure identified in the Bid Schedule.

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
Pre-Cast Concrete (<i>Describe</i>)	Each
Pre-Cast Concrete (<i>Describe</i>)	Lineal Foot

03600.1 DESCRIPTION

This section covers furnishing materials and placing Portland cement grout, epoxy grout, and mortar for finishing concrete surfaces, leveling beds for structural steel plates, sealing joints between piping and structures, and sealing joints between construction components.

03600.1.1 RELATED WORK

Section 03100 - Concrete Forming Finishing, and Curing
Section 03300 - Concrete Structures and Slabwork
Section 04100 - Brick Masonry
Section 04810 - Unit Masonry Assemblies

03600.1.2 SUBMITTALS

Provide description of mix components, which indicates proportions to be used, environmental conditions expected and ad mixture limitations. Indicate type, grade and class of materials which suit the requirements in accordance with Section 01300. Manufacturer's data shall be provided to the ENGINEER for all materials.

03600.1.3 DEFINITIONS

Not used

03600.2 MATERIALS**03600.2.1 PORTLAND CEMENT**

Shall meet ASTM C-150, natural color, Type II (normal) or Type IIA (air entraining).

03600.2.2 HYDRATED LIME

Shall meet ASTM C-207, Type S.

03600.2.3 WATER

Shall be potable, or water which meets the requirements of AASHTO T-26.

03600.2.4 GROUT AGGREGATE

Shall be fine aggregate (generally masonry type sand), which meets the requirements of Section 03050 with a maximum particle size specified therein or on the DRAWINGS.

03600.2.5 PORTLAND CEMENT GROUT

Shall be one part Portland Cement to one part grout aggregate proportioned by volume. Mix for 5 minutes with sufficient water to achieve the consistency of thick cream. Minimum Compressive Strength - ASTM C-109, 2800 psi in 28 days.

03600.2.6 SHRINKAGE RESISTANT GROUT

Shall be a pre-mixed, non-metallic, non-corrosive, non-staining product containing selected silica sands, Portland Cement, shrinkage compensating agents, plasticizing and water reducing agents.

Minimum Compressive Strength - ASTM C-109, 6500 psi in 28 days. Maximum Shrinkage - ASTM C-827 and ASTM C-157, shall not exceed 0.5 percent.

03600.2.7 EPOXY ADHESIVE GROUT

Shall be two component material suitable for use on dry or damp surfaces and shall comply with ASTM C-881. Minimum Pot Life shall be 5 minutes at 70°F. Minimum Tensile strength - ASTM D-638, 5000 psi in 14 days. Minimum Tensile Elongation - ASTM D-638, 2 percent. Minimum Compressive Strength - ASTM D-695, 6500 psi in 24 hours at 70°F, 12,500 psi in 28 days at 70°F. Maximum Water Absorption - ASTM D-570, 1 percent. Minimum Bond Strength shall be: in Direct Shear - 400 psi; in Direct Tension - 250 psi; in Beam Break - 800 psi.

03600.2.8 MORTAR

Shall be a mixture of grout aggregate, all of which passes the No. 4 sieve size, Portland Cement, hydrated lime, and water blended to form a plastic putty meeting the requirements of ASTM C-270. Mortars for brick or concrete block masonry construction shall be Type S or M, mixed in the proportions indicated in the table shown below and manufactured in accordance with the Uniform Building Code. Type S mortar shall be used in masonry sections above grade and not subject to water submergence. Type M mortar shall be used in locations below grade and/or where water contact potential is high.

MORTAR MIXING PROPORTIONS (by volume)

Mortar	Portland Cement	Hydrated Lime	Clean Sand
Type "S"	1	½	4½
Type "M"	1	0	2½

03600.3 CONSTRUCTION REQUIREMENTS

The CONTRACTOR shall prepare and install grout and mortar materials in accordance with these Specifications. The materials shall be mixed in clean containers, which will not allow contamination from deleterious materials. After mixing, the CONTRACTOR shall immediately install the grout or mortar. Grout or mortar left unused one hour after mixing shall be discarded.

03600.4 METHOD OF MEASUREMENT

03600.4.1 NO MEASUREMENT

Grout for leveling of structural components, sealing joints and gaps, finishing concrete surfaces, and filling masonry cells for structures shall not be measured separately for payment.

Mortar used for installing brick or concrete masonry units, or for finishing concrete surfaces, shall not be measured separately for payment.

03600.4.2 SEPARATE MEASUREMENT

Grout installed under pressure for filling voids and pockets under footings and supporting sections and for sealing ground water movement shall be measured by the cubic foot of grout injected in place.

03600.5 BASIS OF PAYMENT

The accepted quantities shall be paid for at the contract unit price for:

PAY ITEM	UNIT
Grout (<i>Description</i>)	Cubic Foot

**03 11 01 SP
WATERSTOPS**

1. GENERAL

1.1. DESCRIPTION:

- A. Utility investigation at all connections to existing pipe and all utility crossings.

1.2. QUALITY ASSURANCE:

Reference standards.

- A. U.S. Corps of Engineers, CRD C-572
- B. Tennessee Valley Authority (T.V.A.) Specification No. PF-1001.

1.3. PRODUCT HANDLING:

- A. Protect waterstops from damage, sun, and weather during storage.

1.4. INSPECTION:

Prior to concrete placement and after waterstops have been positioned, waterstops are to be inspected by the Engineer for correct splicing and for correct, secure, positioning.

2. PART 2 MATERIALS

2.1. MATERIALS

- A. Expansive rubber waterstops shall be Adeka MC-2010M, Spearfish SD, Greenstreak CJ-1020-2K Hydrotite, St. Louis MO, or equivalent acceptable to the Engineer unless noted otherwise on drawings.

3. PART 3 EXECUTION

3.1. PREPARATION FOR WATERSTOPS:

- A. Waterstops shall be cut and/or spliced so that they are at least the full length of the concrete joint.
- B. End cuts shall be straight and square.

3.2. INSTALLATION OF EXPANSIVE WATERSTOPS:

- A. Concrete surfaces shall be clean, dry, frost-free, and primed in accordance with the manufacturer's recommendations.

- B. Waterstops shall be applied in accordance with the manufacturer's recommendations and shall adhere tenaciously to the primed concrete surface.

- END OF SECTION -

03 11 02 SP
POST-TENSIONING TENDONS

1. GENERAL

1.1. DESCRIPTION:

This section covers the furnishing and installation of post-tensioning tendons and accessories and the stressing of the tendons.

1.2. QUALITY ASSURANCE:

A. Reference Standards:

1. American Concrete Institute (ACI) Standards:
 - a. 350 Code Requirements for Environmental Engineering Concrete Structures.
 - b. 315, Manual of Standard Practice for Detailing Reinforced Concrete
 - c. 301, Specifications for Structural Concrete
2. Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice
3. Post-tensioning Institute (PTI), Post-Tensioning Manual
4. AWWA D115 Circular Prestressed Concrete Water Tanks With Circumferential Tendons
5. As modified by the Contract Documents

1.3. POST-TENSIONING SUPPLIER AND INSTALLER:

A. In consideration of the unique nature of post-tensioned concrete construction, coordination between placement of both post-tension and plain reinforcement, and the requirements for proper structure performance, the following requirements shall be met:

1. Post-tensioning systems shall be produced by a Post-Tensioning Institute (PTI) Certified Plant. Post-tensioning systems shall be by VSL.
2. The sub-contractor that supplies the post-tensioning system shall be required to superintend and place with its own personnel both the post-tensioning and plain reinforcing steel.
3. Post-Tensioning Specialist: A specialist shall be at the site full-time to direct the field handling, placement, and stressing of tendons. The specialist shall have had comparable experience (acceptable to the Engineer) in post-tensioning major structures (reservoirs or bridges) now giving satisfactory service, and shall have at least 5 years' experience and technical knowledge in the particular post-tensioning system used.

1.4. SUBMITTALS:

All submittals shall be made in accordance with Section 01340.

- A. Shop Drawings. Show tendon properties, sizes, spacing, quantities, dimensions, accessories, locations, and anchorages on drawings. Indicate tendon coding, stressing sequence, initial and final forces, and anticipated elongations. Provide support drawings showing all bars, chairs, blocks, or other supports.
- B. Detailed computations clearly presented indicating minimum forces required, assumed prestressing losses, final working stresses and stressing sequence, to be submitted with shop drawings. Computations shall be performed by a registered professional engineer specializing in prestressed concrete design.
- C. Certificates: Certified mill reports on the prestressing steel used. Show ultimate strength, modulus of elasticity and percent elongation at rupture.
- D. Reports on three individual prior static tests and three individual prior dynamic tests made in accordance with Chapter 3, PTI Post-Tensioning Manual.

1.5. PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Tendons shall be delivered clearly identified for location. Each shipment shall be accompanied by a cutting list indicating number of tendons, length, code of tendons, anchorages, wedges, grommets, and support chairs. Fabricate tendons in a sequence and quantity as to avoid project slow down or lengthy storage at the site.
- B. Tendons shall be protected at the site against weather and damage. Rusting will not be allowed. Damage to sheathing covering of tendons will not be allowed. Burning or welding shall not be done in vicinity of tendons.

2. MATERIALS

2.1. PRESTRESSING TENDONS

- A. Strands shall be 0.5- or 0.6-in. diameter, 7-wire low relaxation strand, grade 270, conforming to ASTM A 416.
- B. Anchorages shall develop at least 95 percent of minimum specified ultimate strength of prestressing steel without exceeding anticipated set. The total elongation under ultimate load of tendon shall not be less than 2 percent measured in a minimum gauge length of 10 feet.
- C. All unbonded tendons shall be fully encapsulated in accordance with PTI Specifications for a corrosive environment and completely and permanently protected against corrosion by a properly applied coating of grease with rust inhibitor. Unbonded tendon anchorages shall be completely coated with plastic, General Technologies, or equivalent acceptable to the Engineer.
- D. Sheathing for unbonded tendons shall be extruded onto the greased strand and shall have a minimum thickness of 50 mils and sufficient strength and wear resistance to resist deterioration and unrepairable damage. Sheathing shall be continuous over the tendon length and shall prevent intrusion of cement paste and escape of coating material. All tears or holes in sheathing shall be repaired in a waterproof fashion acceptable to the Engineer prior to concrete placement.

- E. Grouted tendons shall be manufactured by VSL. The horizontal wall tendon ducts shall have waterproof connections. They may be covered by heat shrink plastic, 2-in. wide Tapecoat CT by the Tapecoat Company, Evanston, Illinois or equivalent acceptable to the Engineer. Connections shall also be mechanically coupled to prevent displacement.
- F. Ducts for Grouted Tendons. The horizontal wall tendons shall be enclosed in corrugated polyethylene ducts specially manufactured for post-tensioning tendons by VSL. The horizontal tendon ducts shall have a minimum 2-in. nominal inside diameter with 3/16-in. corrugations. The ducts for vertical tendons, when bonded, shall be flat ducts approximately 1-in. by 3-in. inside with similar corrugations.
- G. Vapor phase corrosion inhibitors for bonded tendons shall be VPI crystals, as manufactured by Shell Oil Co., or equivalent.
- H. Couplings shall not be used except at locations specifically indicated on Contract Documents, unless otherwise approved by the Engineer.
- I. Grout for injection grouting of bonded tendons shall be Prepackaged Class C per PTI Specifications.***
- K. Epoxy Sealant. Epoxy sealant shall be two-component, moisture insensitive, low viscosity, solvent free, epoxy resin, Sikadur 35, Hi-Mod LV or equivalent acceptable to the Engineer.
- L. Bonding Agent. Bonding agent shall be either a two-component, moisture insensitive epoxy adhesive, Sikadur 32, Hi-Mod or equivalent acceptable to the Engineer, or neat cement grout.

3. EXECUTION

3.1. INSTALLATION:

- A. Tendon supports shall be adequate to prevent displacement. Tie tendons to reinforcement or chairs to secure in proper location. Tendons are to be secured at a maximum of 4-foot centers except as noted for the floor slab tendons.
- B. Placement tolerances: Tendons are to be positioned in exact locations shown within the thickness of the member. Deviations, when required, shall be no more than $\pm 1/8$ in..
- C. Bar Supports:
 - 1. Provide continuous #5 support bars at a maximum of four feet on center under the roof tendons.
 - 2. All reinforcement shall be tied to chairs to secure them from displacement during concrete placement. Reinforcement shall be secured at a maximum distance of four feet on center. All chairs shall be stapled to wooden soffits. Staples and tie wire only shall be used to secure chairs to forms, except as reviewed by the Engineer.
- D. Concrete shall be placed so that alignment of tendons remains unchanged.

3.2. STRESSING

- A. Score the tendon tails with a grinding wheel (or by another permanent marking method acceptable to the Engineer) at 10 in. (or other dimension outside of the

gripper zone acceptable to the Engineer) from the anchorage prior to any stressing.

- B. Prestressing force shall be determined by both of the following methods:
 - 1. Measurement of tendon elongation.
 - 2. Reading of jacking force on calibrated gauge or load cell, or by use of a calibrated dynamometer.
- C. The cause of any difference in force determination between D-1 and D-2 greater than seven percent shall be ascertained and corrected. Accurate logs of actual tendon elongations and jacking forces shall be kept by the Contractor and submitted to the Engineer after completion of the stressing operation and prior to removing the stressing tails.

3.3. GROUTING OF STRESSING POCKETS

- A. The stressing pockets shall be grouted as soon as practicable after the Engineer's review of the elongation records. Coat the stressing pockets with bonding agent and fill with the specified non-shrink grout prior to setting or drying of the bonding agent.

- END OF SECTION -

03 11 03 SP
FORMWORK FOR AWWA D115 TANK

1. GENERAL

1.1. DESCRIPTION:

This section covers furnishing, erecting, and removing of forms for cast-in-place concrete.

1.2. QUALITY ASSURANCE:

A. Reference Standards:

1. American Concrete Institute Standards (ACI)
 - a. 301 Specifications for Structural Concrete.
 - b. 347 Guide to Formwork
 - c. As modified herein.

B. Design Criteria:

1. The Contractor shall design the formwork for the loads, lateral pressures and allowable stresses outlined in Chapter 1 of ACI 347.

B. Maximum Allowable Tolerances:

1. Variation from Plumb
 - a. Lines and surfaces of columns, piers, and walls
 1. In any 10 feet of length 1/4 in.
 2. Entire length 1 in.
 - b. Control-joint grooves, and other conspicuous lines
 1. In any 20 feet of length 1/4 in.
 2. In 40 feet or more 3/4 in.
2. Variation from level or specified grade
 - a. Slabs, beams, and roof
 1. In any 10 feet of length 1/4 in.
 2. In any 20 feet of length 3/8 in.
 3. Entire length 3/4 in.
 3. The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between supporting members.
 4. Refer to ACI 301 for additional requirements.

2. PRODUCTS

2.1. FORM MATERIALS:

- A. General: Where “Smooth Form Finish,” or “Grout Cleaned Finish” is specified, use prefabricated plywood panel forms, job-built plywood forms, forms lined with plywood or fiberboard, or steel forms. Where “Rough Form Finish” is specified, unlined wooden forms may be used. Use maximum two-foot wide straight segments to form circular tank walls. The forms may be steel or plywood.

- B. Steel Forms: Symons "Steel-Ply," Simplex "Industrial Steel FrameForms," Universal "Uniform" or equivalent.
- C. Plywood Forms: Product Standard PS-1, - waterproof, 3/4 in. MDO plywood or better.
- D. Fiberboard Forms: Federal Spec LLL-B-810 - Type II tempered, waterproof, screenback, concrete form hardboard.
- E. Lumber (Including Board and Batten Forms): Straight, uniform width and thickness, free from knots, offsets, holes, dents, and other surface defects. Lumber must be sufficiently sealed to prevent the absorption of water, form release agent, etc.
- F. Chamfer strips: Clear white pine, surface against concrete planed.
- G. Form ties:
 - 1. Removable end, permanently embedded body type with waterstop.
 - 2. Sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders.
 - 3. When cones are provided on the outer ends the permanently embedded portion shall be back a minimum of one in. from concrete surface.
 - 4. Permanently embedded type without threaded ends shall be so constructed so that removable ends are readily broken off (one in. back from concrete surface) without damage to the concrete.
 - 5. Form ties in exposed surfaces shall be uniformly spaced and aligned in horizontal and vertical rows.
 - 6. Taper ties may be used. Upon removal of taper ties holes will be sealed with an A58 sure plug capable of withstanding a hydrostatic pressure of 70 ft of liquid head.
- H. Joints: Joints shall be flat, not keyed, with expansive waterstops, unless otherwise shown on Drawings.
- I. Polyethylene Film: Product Standard PS17; 6 mil.
- J. Form Coating:
 - 1. Non-staining chemical release agent that will not damage the concrete surfaces and appropriate for use in potable water structures.
 - 2. For all exposed surfaces not in contact with earth backfill use Symons Corp. "Magic Kote", or equivalent.

3. EXECUTION

3.1. ERECTION:

- A. General:
 - 1. Erect forms substantial and sufficiently tight to prevent leakage of mortar and braced or tied to maintain the desired position, shape, and alignment before, during and after concrete placement. At vertical wall joints where forms overlay existing concrete, a mortar tight joint shall be required. Use a bead of silicone caulking or foam joint filler against concrete before placing form. Alternate methods shall be acceptable to the Engineer.

2. Use adequate walers, stiffeners and braces to insure proper alignment and stability until the wall construction is completed.
3. Provide temporary openings at the bottom of column and wall forms and at other locations where necessary to facilitate cleaning and inspection.
4. Temporary openings in wall or column forms used to limit the free fall of concrete to a maximum of 4 feet shall be located to facilitate placing and consolidation of the concrete. Such openings in walls shall not exceed 8 feet laterally to avoid moving concrete laterally more than 4 feet.
5. If tremies of proper length are used for depositing concrete in walls or columns, temporary openings for concrete placement will not be required.
6. Bring forms to a true line and grade, or provide a wooden guide strip at the proper location on the forms so that the top surface can be finished with a screed or template for concrete which is to have a specified elevation, slope or contour.
7. At horizontal construction joints in walls, do not extend the forms on one side more than 2 feet above the joint. Horizontal construction joints shall not be used in walls of water retaining structures or exposed walls, unless reviewed and accepted by the Engineer.

B. Embedded Items:

1. Anchor bolts, castings, steel shapes, conduits, sleeves, waterstops, masonry anchorage and other materials that are to be embedded in the concrete shall be accurately positioned in the forms and securely anchored.
2. Install conduits in walls or slabs with reinforcement in both faces between the two faces of reinforcing steel.
3. In walls or slabs which have only a single mat of reinforcing steel, place conduits near the center of the wall or slab.
4. Unless installed in pipe sleeves, provide anchor bolts with sufficient threads to permit a nut to be installed on the concrete side of the form or template.
5. Install a second nut on the other side of the form or template and adjust the two nuts so the bolt will be held rigidly in proper position.
6. Assure embedments are clean when installed.
7. After concrete placement, clean surfaces not in contact with concrete of concrete mortar and other foreign substances.

C. Preparation of Form Surfaces:

1. Remove mortar, grout, and other foreign material from form surfaces.
2. Coat form surfaces with form coating material before either the reinforcing steel or concrete is placed. Ensure that dimension lumber board and batten forms are properly sealed so that they do not absorb form coating or water.
3. Do not allow form coating to:
 - a. Stand in puddles in the forms.
 - b. Come in contact with the reinforcing steel.
 - c. Come in contact with adjacent hardened concrete against which fresh concrete is to be placed.

D. Edges and Corners:

1. Place chamfer strips in forms to bevel exposed edges and projecting corners. Tool the top edges of walls and slabs not indicated on the Drawings to be beveled.
2. Form beveled edges for all vertical and horizontal corners of equipment bases unless indicated otherwise on the Drawings.
3. Chamfer strip shall be 3/4 in. unless indicated otherwise on the Drawings.

E. Removal:

1. Do not remove or disturb forms until the concrete has attained sufficient strength to safely support all dead and live loads.
2. For prestressed beams, slabs, and similar sections the shores and supports shall remain in place until the concrete has reached 85 percent of the specified 28-day strength and the post-tensioning operation is complete. Determine strength from maturity meters or job cured cylinder breaks. Cylinders shall be job cured in same manner as the formed concrete.
3. Retain shoring in place and reinforce as necessary to carry out construction equipment, materials or other loads in excess of cured strength. Brace walls and columns after removal of forms to resist wind and construction loads.
4. Use care in form removal to avoid surface gouging, corner, or edge breakage, and other damage to the concrete.
5. Do not commence form removal for concrete not yet supporting loads, earlier than the following schedule, unless field cured cylinders and/or maturity meters indicate the concrete has reached 85 percent of the specified 28-day strength:

a. Walls and columns	16 hours
b. Vertical sides of beams and girders	24 hours
c. Bottom forms and shoring for nonprestressed slabs,	
1. beams and girders under 10 feet clear span	
2. between permanent supports.	7 days
d. Bottom forms and shoring for nonprestressed slabs,	
1. beams and girders between 10 and 20 feet clear	
2. span between permanent supports.	14 days
e. Bottom forms and shoring for nonprestressed slabs,	
1. beams and girders over 20 feet clear span between permanent supports.	21 days
6. Refer to ACI 347, Chapter 2, for additional requirements.

- END OF SECTION -

03 20 01 SP
REINFORCEMENT FOR AWWA D115 TANK

1. GENERAL

1.1. DESCRIPTION:

This section covers furnishing and installing steel bars and welded wire fabric for concrete reinforcement.

1.2. QUALITY ASSURANCE:

A. Reference Standards:

1. American Concrete Institute Standards (ACI)
 - a. 301 Specifications for Structural Concrete.
 - b. 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures.
 - c. 350 Code Requirements for Environmental Engineering Concrete Structures.
2. As modified herein or on the Drawings.

B. Allowable Tolerances:

1. Fabrication Tolerances
 - a. Sheared length: ± 1 in.
 - b. Depth of truss: +0, -1/4 in. for concrete thickness 24 in.es or less and +0, -1/2 in. for concrete thickness over 24 in.es.
 - c. Overall dimensions of stirrups, ties, and spirals: +0, -1/4 in. for concrete thickness 24 in.es or less and +0, -1/2 in. for concrete thickness over 24 in.es.
 - d. All other bends ± 1 in..
2. Placement Tolerances
See Section 3-2.C

C. Welding:

Do not weld reinforcement except where indicated on the Drawings for welded splices. Tack welding of reinforcement is not permitted, except where specified by the Engineer.

1.3. SUBMITTALS:

All submittals shall be made in accordance with the General Conditions.

A. Shop Drawings:

1. Before fabrication of reinforcing steel, the Contractor shall review and approve shop drawings, bar lists, fabrication and setting drawings and shall submit the same to Engineer for review.
2. Show sizes, quantity and dimensions for fabrication and placing of reinforcing bars and bar supports. Indicate bar schedules, stirrup spacing, and diagrams of bent bars.

- B. Certificates: Mill test certificates identifying chemical and physical analysis of each load of reinforcing steel delivered.
- C. Manufacturer's Literature: Manufacturer's specifications and installation instructions for splice devices when these devices are called for on the Drawings.

1.4. PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver to site in bundles marked with metal tags indicating bar size and length.
- B. Carefully handle and store on supports that will keep the steel from coming in contact with the ground or standing water.

2. PRODUCTS

2.1. REINFORCEMENT BARS:

- A. Bars: Steel reinforcement bars shall be new, deformed billet steel, meeting ASTM A 615; Grade 60 for reinforcing bars No. 4 and larger; Grade 40 for No. 3 reinforcing bars and designated reinforcement.
- B. Tie Wire: Annealed steel, Fed. Spec. QQ-W-461, 16 gauge minimum.
- C. Fabrication: In accordance with CRSI Manual of Standard Practice except for the allowable tolerances specified herein in 1-2B.

2.2. BAR SUPPORTS:

- A. Conform to "Bar Support Specifications," CRSI Manual of Standard Practice.
- B. The portions of the supports or accessories within ½ in. of the concrete surface shall be coated with plastic at least 3/32-in. thick at points of contact with the formwork. Other requirements shall be in accordance with Class 1, maximum protection, plastic protected bar supports, in Chapter 3 of the Manual of Standard Practice by CRSI.
- C. The concrete block supports at the base of the wall and for the slab-on-grade shall be a minimum of 4000 psi compressive strength. They shall be 3- or 4-in. es square, thickness as required.

3. EXECUTION

3.1. PREPARATION:

- A. Remove all mud, oil, loose rust or mill scale or other foreign materials that may reduce bond.
- B. Rust or mill scale that is "tight" will be permissible without cleaning or brushing provided weights, dimensions, cross-sectional area, and tensile properties meet requirements of ASTM A 615.

3.2. INSTALLATION:

- A. Bar Placement:
 - 1. Conform to CRSI-WCRSI "Placing Reinforcing Steel."
 - 2. Reinforcement shall be supported and wired together to prevent displacement by construction loads or the placing of concrete.
- B. Bar Supports:
 - 1. Provide at least the number of supports as required by ACI 315.
 - 2. All reinforcement shall be tied to chairs to secure them from displacement during concrete placement. Reinforcement shall be secured at a maximum distance of four feet on center. All chairs shall be stapled to wooden soffits. Staples and tie wire only shall be used to secure chairs to forms, except as reviewed by the Engineer.
 - 3. Do not use pebbles, pieces of broken stone, common or face brick, metal pipe or wood blocks to support reinforcement.
 - 4. Spacing of supports for the floor tendons and reinforcement shall be at the spacing of the bars, each way.
- C. Placement Tolerances:
 - 1. Clear distance to formed surface: See 3-2D Concrete Cover 1. and 2.
 - 2. Minimum spacing between bars: $-1/4$ in.
 - 3. Top bars in slabs and beams: See 3-2D Concrete Cover 1 and 2.
 - 4. Spacing crosswise of members: Spaced evenly within 2 in.es.
 - 5. Lengthwise of members: ± 2 in.es.
 - 6. Maximum bar movement to avoid interference with other reinforcing steel, conduits, or embedded items: one bar diameter. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars may be rejected by the Engineer.
- D. Concrete Cover:
 - 1. Except as otherwise indicated on the Drawings, provide the following minimum concrete cover for reinforcement.
 - a. Unformed surfaces adjacent to excavation

Non-prestressed Concrete	3 in.es
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 - b. Formed or top surfaces exposed to weather or saturated air, submerged or in contact with earth

Non-prestressed Concrete	2 in.es
Prestressed Concrete	1 ½ in.es
 - c. Other locations:
 - Bars in beams or columns, including stirrups & ties: 2 in.es
 - 2. Cover for reinforcing steel shall not be less than the minimum given above (no minus tolerance), and shall not exceed the minimum by more than 1/4 in. where concrete thickness is 24 in.es or less, or more than ½ in. where the concrete thickness is more than 24 in.es.
 - 3. For circular columns and drilled piers, three equally spaced plastic disks (Plas-T-Clips) distributed by Spillman Company, Columbus, Ohio or equivalent (acceptable to Engineer) at 4 feet on center shall be used to space the column reinforcing away from the forms and drilled pier reinforcement away from the earth.

- E. Reinforcement Adjustment:
 - 1. Move only as stated under 3-2 C 6.
 - 2. Do not heat, bend, or cut bars without Engineer's acceptance.
 - 3. Grade 60 bars shall not be bent after being partially embedded in hardened concrete.
- F. Splices:
 - 1. Do not splice bars except at locations shown on the Drawings without the Engineer's acceptance.
 - 2. Minimum lap distance shall be as shown on the Drawings. If not shown, splices shall be Class B tension lap splice as specified in ACI 350.
 - 3. Tie splices securely to prevent displacement by construction loads or during placement of concrete.
 - 4. Splices in horizontal wall reinforcement in circular tanks shall be staggered such that no more than one bar in two is spliced in any four foot wide vertical section.
 - 5. Reinforcement shall be continuous around corners or corner bars provided.
- G. Welding: Reference 1-2C, 1-3C and 2-1E.

- END OF SECTION -

03 30 10 SP
CONCRETE PLACEMENT
(COLD WEATHER PROCEDURES)

Add the following items to Section 03 30 10 when the Definition of Cold Weather is met.

Definition of Cold Weather: Cold weather is defined as a period when for more than three (3) successive days the mean daily temperature falls below 40° F or any day when the temperature is expected to fall or falls below freezing.

1. GENERAL

1.1. REFERENCES

- A. APWA:
1. Section 03 30 04: Cast-In-Place Concrete
 2. Section 03 39 00: Concrete Curing
 3. Section 03 30 10: Concrete Placement

1.2. SUBMITTALS

- A. Not less than 30 days prior to expected placement of concrete under cold weather conditions, a complete procedure shall be submitted for review covering all aspects of protection of concrete and its ingredients from the detrimental effects of cold weather. Concrete placement during cold weather shall not commence prior to return of the procedure marked "Reviewed".

1.3. QUALITY ASSURANCE

- A. The concrete temperature, during placement in cold weather, shall not be less than 50° F. Temperature measurements of the concrete as delivered to the job site shall confirm this requirement.

2. PRODUCTS

2.1. MATERIALS

- A. Water and aggregates may be preheated for cold weather placement; however, their temperature shall not exceed 150° F. All methods and equipment for heating of water and aggregate shall be subject to the approval of the Engineer and shall conform to ACI 306.

3. EXECUTION

3.1. PREPARATION

- A. No concrete shall be placed on frozen ground.
- B. The ground, against which concrete is to be poured, must be protected against freezing after its preparation, or the concrete placement shall be delayed until the ground has fully thawed out.
- C. When temperatures are expected to be below 32° F. the night before the concrete is placed, then all reinforcing steel, forms and the ground shall be preheated, for a minimum of 12 hours, under a minimum temperature of 50° F.
- D. When temperatures are expected to be below 32° F any time before the concrete has reached a strength of 1000 psi, the concrete must be adequately protected against frost damage by heating blankets, straw, or insulation materials for a minimum of 7 days or until at least 1000 psi concrete strength has been reached. The concrete temperature shall at no time fall below 40° F based on recording temperature monitors placed at a maximum of 50 feet on centers, each way, and around the circumference of the floor slab, and retaining wall. Contractor shall provide heat as required to keep the concrete temperature as specified throughout the entire curing period of 7 days.
- E. Weather prediction made by the nearest NOAA station, and corrected for the local elevation and environmental conditions, may be used to determine whether cold weather protection shall be required. Thermometers will be used by the Engineer and these readings shall determine whether cold weather protection shall be required and whether cold weather protection is adequate.
- F. When combustion type heaters are used to maintain concrete temperatures within an enclosure, the exhaust gases shall be vented from the heater to the outside atmosphere so that the concrete is not exposed to the products of combustion.

- END OF SECTION -

03 30 11 SP
CAST-IN-PLACE CONCRETE FOR AWWA D115 TANK

1. GENERAL

1.1. DESCRIPTION:

- A. This section covers cast-in-place concrete, including furnishing materials, transporting, placing, finishing, curing and other appurtenant items of construction.
- B. Inform Engineer at least 2 weeks in advance of time and places at which Contractor intends to place concrete. All preparation work for concrete placements shall be substantially completed at least 2 workdays prior to the scheduled start of concrete placement to allow for the Engineer's review and any necessary corrections.

1.2. QUALITY ASSURANCE:

- A. Reference standards.
 - 1. Except as noted or modified in this Section, all concrete materials, transporting, placing, finishing, and curing shall conform to requirements of following standard specifications:
 - a. American Concrete Institute Standards (ACI)
 - 1) 301 Specifications for Structural Concrete.
 - 2) 304 Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete.
 - 3) 304 Placing Concrete by Pumping Methods.
 - 4) 305 Recommended Practice for Hot Weather Concreting.
 - 5) 306 Recommended Practice for Cold Weather Concreting.
 - 6) 308 Standard Practice for Curing Concrete.
 - 7) 309 Recommended Practice for Consolidation of Concrete.
 - 8) 350 Code Requirements for Environmental Engineering Concrete Structures.
 - b. American Society for Testing and Materials (ASTM).
- B. Contractor shall keep at least one copy of above listed ACI publications, latest edition, in project field office at all times.
- C. Any material or operation specified by reference to the published specifications of a manufacturer shall be complied with unless directed otherwise by the Engineer.
- D. In case of a conflict between the referenced specifications or standards and this Specification, the one having the more stringent requirements, as determined by the Engineer, shall govern.

1.3. SUBMITTALS:

All submittals shall be made in accordance with the General Conditions. Mix designs, shop drawings and catalog information shall be submitted for related equipment and

components, in order to show that concrete and items selected and to be installed by the Contractor generally conform to the Contract Documents. Submittal information includes, but is not necessarily limited to the following:

- A. Miscellaneous product information.
 - 1. Catalog information and shop drawings for: waterstops, admixtures, bonding agents, membrane curing compound, joint sealer, embedded items, non-shrink grout, wedge-type expansion anchors, and other concrete appurtenances.
- B. Proposed concrete mix design. (Note: Contractor shall be responsible for fully informing the concrete supplier of all specification requirements regarding the concrete mix before the proposed mix design is submitted.)
 - 1. The proportions of ingredients shall be selected to produce the proper workability (slump), durability (air content), strength, maximum water-cementitious materials ratio, time of set and other required properties of Sections 2-1 and 2-2.

The proportion of ingredients shall be such as to produce a mixture with slump and durability that will work readily into the corners and angles of the forms and around reinforcement by the methods of placing and consolidation employed on the work. Do not permit the materials to segregate or excessive free water to collect on the surface.

An independent testing laboratory acceptable to the Engineer shall perform concrete trial mixtures and testing. The costs of the mix designs and testing shall be borne by the Contractor.
 - 2. Prior to commencing concrete work, submit and obtain Engineer's review of certified test reports describing proposed concrete mix design, which shall be prepared in compliance with ACI Standard 301, with concrete proportions established on the basis of previous field experience or laboratory trial batches, except as modified herein. Test reports shall also include:
 - a. Fine aggregates - Source, type, gradation, deleterious substances, and bulk specific gravity on basis of weight of saturated surface-dry aggregate. ASTM C 128.
 - b. Coarse aggregate - Source, type, gradation, deleterious substances, and bulk specific gravity on basis of weight of saturated surface-dry aggregate. ASTM C 127.
 - c. Ratio of fine to total aggregates.
 - d. Weight (saturated surface-dry) of each aggregate per cubic yard.
 - e. Total water content in gallons per cubic yard.
 - f. Slump on which design is based.
 - g. Brand, type, and quantity of cement.
 - h. Brand, type, and quantity of admixtures.
 - i. Water-cementitious materials ratio (shall be not greater than specified in Part 2-2).
 - j. Air content (which shall be within the upper half of the allowable range).

- k. For the laboratory trial batches method, the determination of the cementitious materials content necessary to attain the required strength and other properties, without exceeding the maximum water-cementitious materials ratio, shall be by preliminary tests in accordance with the following procedures:
 Concrete trial mixtures having proportions and consistency suitable for the work shall be made using at least three different cementitious materials contents which will produce a range in strengths encompassing those required for the work.
 Proportions of ingredients shall be determined and tests conducted in accordance with the basic relationships and procedures outlined in "Recommended Practice for Selecting Proportions for Normal and Heavy-Weight Concrete (Part I):" (ACI 211.1).
 For each cementitious materials content, at least three specimens for each age to be tested shall be made and cured in accordance with "Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Laboratory" (ASTM C 192) and tested for strength at 1, 7, and 28 days. Tests shall be conducted in accordance with "Method of Test of Compressive Strength of Molded Concrete Cylinders" (ASTM C 39).
 From the results of these tests, a curve shall be plotted showing the relationship between cementitious materials content and the average 28-day compressive strength. The minimum cementitious materials content to be used shall be that value shown by the curve to produce a strength of at least 1500 psi in 24 hours and at least 1200 psi greater than the 28-day strength specified. In any case, the minimum cementitious materials content shall not be less than that specified in Part 2-2.
 If the previous field experience method is used in proportioning, the strengths shall be in compliance with ACI 301. In addition, the Contractor shall demonstrate the ability of the proposed mixture proportions to produce concrete meeting all the requirements of these Specifications.
 - 1. Maturity meter calibration curves.
- 3. In addition to the test data described above, when it is expected that concrete will be placed under hot weather concrete conditions as defined in Section 03 30 11, Part 1-6.C, trial batches shall be tested at the maximum temperature that the concrete is expected to be placed. Alternatively, sufficient records may be submitted that show field concrete performance under these temperatures and which are acceptable to Engineer.
- C. Cylinder compression test reports.
 - 1. Submit 2 copies of certified test reports to Engineer for 1-3.B.2.K.
- D. Ready-mix delivery tickets.
 - 1. Submit delivery tickets for each load at time of delivery indicating following:

- a. Quantity delivered with Mix Identification Number.
- b. Quantity of each material in batch.
- c. Outdoor temperature in shade.
- d. Time at which water was added.
- e. Elapsed time between when water was added and concrete load was in place.
- f. Amounts of initial and supplemental water added, including any corrections for water in aggregate. Note: Total water amount shall result in a water-cementitious materials ratio not greater than the maximum permissible.
- g. Name of individual authorizing supplemental water.
- h. Numerical sequence of delivery by indicating cumulative yardage delivered on each ticket.

1.4. PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Cementitious materials.
 - 1. Store in weather-tight enclosures and protect against dampness, contamination and warehouse set.
 - 2. Do not use cementitious materials that have become caked or lumpy.
- B. Aggregates.
 - 1. Stockpile to prevent excessive segregation, or contamination with other materials or other sizes of aggregates.
 - 2. Use only one supply source for each aggregate stockpile.
 - 3. The bottom 6 in. of all aggregate piles in contact with ground shall not be used.
 - 4. Frozen or partially frozen aggregates shall not be used.
- C. Admixtures.
 - 1. Store to prevent contamination, evaporation, or damage.
 - 2. Protect liquid admixtures from freezing or harmful temperature ranges.
 - 3. Agitate emulsions prior to use.
- D. Rubber and plastic materials.
 - 1. Store in cool place away from direct sunlight.
- E. Mixing and transporting ready-mixed concrete.
 - 1. Maximum elapsed time from time water is added to mix until concrete is in place shall not exceed 1-1/2 hours when concrete is transported in revolving drum truck bodies unless all other provisions of these specifications can be met, including maximum water-cementitious materials ratio, workability, strength, and air content. Comply with ASTM C 94.

1.5. JOB CONDITIONS:

- A. Environmental requirements:
 - 1. Do not place concrete during rain, sleet, or snow unless adequate protection is provided, and Engineer's approval is obtained.

2. Do not allow rainwater to increase mixing water or damage surface finish.
 3. For cold or hot weather concreting conditions, lab cured cylinder tests may not be an accurate indication of field achieved strengths. Under these weather conditions, the Engineer may require job cured cylinder breaks to determine field strength (cylinders to be job cured in same manner as the in-place concrete.) The Contractor shall pay for testing. Refer to Section 03300, part 3-10 for related items to be furnished by Contractor. If cold or hot weather concreting practices specified in Sections 1-6.B and 1-6.C are not adhered to, the Engineer may require Contractor, at Contractor's expense, to provide additional pullout tests in accordance with ASTM C 900, job cured cylinder tests, or 2-in. diameter cored samples from areas in question to determine field strengths achieved.
 4. Changes in temperature of the concrete shall be as uniform as possible and shall not exceed 10 Degrees F. in any 1-hour or 45 Degrees F. in any 24-hour period.
- B. Cold Weather Concreting. Conform to ACI 306, "Cold Weather Concreting" in addition to this specification.

1. Temperature of concrete when placed shall not be less than following:

Air Temp. Degrees F	Minimum Concrete Temp, C. Sections with least dimension	
	<u>Under 12 in.</u>	<u>12 in. and Over</u>
30 to 45	60	50
0 to 30	65	55
Below 0	70	60

If water or aggregate has been heated, the water and aggregate shall be combined in the mixer before cementitious materials are added.

Cementitious materials shall not be added to mixture of water and aggregate when the temperature of the mixture is greater than 95 F.

2. When placed, heated concrete shall not be warmer than 80 F.
3. Prior to placing concrete, all ice, snow, surface, and subsurface frost shall be removed, and temperature of surfaces to be in contact with new concrete shall be raised to a minimum of 35 F.
4. Protect concrete from freezing during specified curing period. See Part 3-9, Curing, for temperature to be maintained during initial curing period.
5. When the mean daily temperature of the atmosphere is less than 40 F., forms shall be left in place a minimum of 5 days to aid in retaining heat.
6. Heated enclosures shall be strong and windproof to insure adequate protection of corners, edges, and thin sections.
7. Do not permit heating units to locally heat or dry concrete.
8. Do not use combustion heaters during first 24 hours unless concrete is protected from exposure to exhaust gases, which contain carbon dioxide.
9. If air temperatures drop below 35 F., the Contractor shall install a high-low temperature gauge into the most exposed portion of concrete during the curing protection period. The gauge shall be equipped to register the lowest overnight temperature. If the concrete temperature drops below the

specified temperature, the curing period shall be extended until the degree-days (Part 3-9) are satisfied.

10. Refer to ACI 306 for further requirements.
- C. Hot Weather Concreting: Conform to ACI 305, "Hot Weather Concreting" in addition to this specification.
1. Take precautions when ambient air temperature is 90 F. or above. These measures may include installation of windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering of a light color. If daytime highs are expected to exceed 100 F., floor and roof slab concrete shall be placed overnight, with placement commencing not prior to 3 hours before sunset.
 2. Temperature of concrete when placed shall not exceed 85 F.
 3. Cool forms and reinforcing to a maximum of 90 F. by spraying with water prior to placing concrete.
 4. Do not use cementitious materials that have reached a temperature of 105 F. or more at the time they enter the concrete mix.
 5. Prevent plastic shrinkage cracking due to rapid evaporation of moisture.
 6. Do not place concrete when evaporation rate (actual or anticipated) is 1.0 kg per square m per hour or above, as determined by Figure 2.1.5 of ACI 305.
 7. Set-retarding and water-reducing admixtures may be used when the ambient air temperature is 90 F. or above to offset accelerating effects of high temperature.
 8. Refer to ACI 305 for further requirements.
- D. Protection from Mechanical Injury: During the curing period, the concrete shall be protected from damaging mechanical disturbances particularly load stresses, heavy shock, and excessive vibration. All finished concrete surfaces shall be protected from damage caused by construction equipment, materials, or methods and by rain or running water. Self-supporting structures shall not be loaded in such a way as to over-stress the concrete.

2. PRODUCTS

2.1. CONCRETE MATERIALS:

- A. Cement shall conform to the "Standard Specification for Portland Cement," ASTM C 150, Type II low-alkali. Once cement type is chosen, the type and source shall remain the same throughout the project.
Fly ash shall be Class F (ASTM C 618).
- B. Aggregates.
 1. Fine aggregate - ASTM C 33.
 2. Coarse aggregate - ASTM C 33 Size No. 57 or 67.
 3. Once aggregates are chosen, the same source and type of aggregates shall be used throughout the project.
- C. Water.

1. Shall be clean, fresh, and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement.
- D. Admixtures.
1. Use only as specified or reviewed and acceptable to Engineer.
 2. Include any admixtures to be used in the proposed concrete mix designs.
 3. Calcium chloride is not permitted as an admixture or as an ingredient of an admixture.
 4. Air-entraining Admixture: ASTM C 260.
 5. Water-Reducing and Retarding: ASTM C 494. Use high range water reducing admixture only as specified or if acceptable to the Engineer.
- E. Tests for Chloride Ions.
1. For all concrete in which aluminum or galvanized metal is to be embedded, it shall be demonstrated by tests in accordance with AASHTO T-260 that the hardened concrete, including the aggregates, cementitious materials and any admixtures used, will not contain more than 0.06 percent water soluble chloride ions by weight of cement.

2.2. CONCRETE PRODUCTION:

- A. Ready-mixed concrete.
1. Mixed and delivered, ASTM C 94.
 2. Retempering. Indiscriminate addition of water to increase slump shall be prohibited.
Concrete shall be mixed only in quantities required for immediate use. Concrete that has partially set shall not be retempered, but shall be discarded.
When concrete arrives at the project with slump below that suitable for placing, first the concrete shall be remixed for at least one minute at mixing speed. If the slump is still too low, water may be added only if neither the maximum permissible water-cementitious materials ratio nor the maximum slump is exceeded. The water must be incorporated by additional mixing equal to at least half of the total mixing required. The Engineer must review such addition.
- B. Batching and mixing equipment.
1. Conform to "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete," ACI 304.
- C. Proportioning.
1. Proportion ingredients to produce a well-graded mix of high density and maximum workability consistent with the accepted mix design.
 2. Entrained air, $6 \pm 1\frac{1}{2}$ percent for ASTM C 33 Size 67 or 57 coarse aggregate. Refer to ACI 301 for air entrainment required for other coarse aggregate sizes.
 3. Time of Set.
Six hours plus or minus one hour.
 4. Strength and General Requirements.

Design and proportion concrete to meet the following minimum compressive strengths and other criteria:

<u>Location</u>	<u>Design Strength 28-Day (psi)</u>	<u>ASTM C 33 Aggregate Size No.</u>	<u>Slump ± 2.0 in.</u>	<u>Minimum Cement Content lb/yd³</u>	<u>Minimum Fly Ash Content lb/yd³</u>	<u>Maximum W-C Materials Ratio*</u>
All Tank Concrete	4,500	57 or 67	5.0	525	120	0.42
Cold Weather Slabs	4,500	57 or 67	5.0	600	0	0.42

*The maximum water-cementitious materials ratio by weight, which shall be based on all water in the mix, including correction for moisture in aggregates, and shall be based on the total cementitious materials including cement and fly ash, if any.

2.3. CONCRETE ACCESSORY MATERIALS:

- A. Curing Materials.
 - 1. Sheet material: ASTM C 171
 - 2. Liquid membrane: membrane-curing compound shall be in accordance with ASTM C 309. Membrane curing compound shall be sprayable, 18% minimum solids content, US Spec Max Cure Resin Clear High Solids or equivalent acceptable to Engineer.
- B. Joint Sealers.
 - 1. Joint Sealer: Joints indicated on Drawings, shall be sealed with a polyurethane joint sealer material of uniform, non-sag or self-leveling consistency as indicated. The sealant shall, when installed, tenaciously adhere to primed concrete surfaces and shall remain permanently elastomeric.
 The material shall be of a type that will, when properly installed, effectively and permanently seal joints subject to minor movements. Install with primer and cure in accordance with the manufacturer's instructions and recommendations.
 Except as noted on the Drawings, joint sealer shall be Sikaflex 2C-NS or 2C-SL Elastic Sealant/Adhesive, as manufactured by Sika Chemical Corporation or other material acceptable to the Engineer. Add color as required to match adjacent surfaces where exposed to view.
- C. Non-Shrink Grout: Non-shrink grout shall be "Masterflow 713" or equivalent acceptable to the Engineer. Grouts with iron filings are not acceptable. The grout shall be compatible with the surface to be bonded.
- D. Epoxy Bonding Agent: Bonding agent shall be a two component moisture insensitive epoxy adhesive, Sikadur 32, Hi-Mod or equivalent acceptable to the Engineer.
- E. Expansion Joint Filler Material: Joint filler material shall be closed cell neoprene or rubber conforming to ASTM D 1056, Grade 2A3. Material shall be glued securely to concrete surfaces.

- F. Wedge-Type Expansion Anchors: Expansion bolts and anchors fastened to concrete shall be stainless steel; "KWIK-BOLT" manufactured by Hilti, Inc., Phillips Red Head wedge anchors, or equivalent acceptable to Engineer.
- G. Epoxy Sealant: Epoxy sealant shall be a two-component, moisture insensitive, low viscosity, solvent free, epoxy resin, Sikadur 35, Hi-Mod LV or equivalent acceptable to the Engineer.
- H. Concrete Support Blocks: Concrete support blocks for the floor reinforcement and the support of the vertical reinforcement at the base of the wall shall be a mixture of portland cement, sand, and water with a minimum compressive strength of 4000 psi.
- J. Waterstops: Expansive waterstops shall be Adeka or Greenstreak, size as indicated on the drawings, see Spec. section 3253

3. EXECUTION

3.1. INSPECTION:

- A. General.
 - 1. Assure that excavations and formwork are completed.
 - 2. Assure that dirt, mud, encrusted concrete, debris, and excess water have been removed.
 - 3. Check that reinforcement is properly positioned and secured in place.
 - 4. Verify that expansion joint material, anchors, and other embedded items are secured in proper position.

3.2. PREPARATION:

- A. General.
 - 1. Remove any hardened concrete and foreign material from inner surface of conveying equipment.
 - 2. Prepare slab subgrade in accordance with ACI 301 and ACI 350, appendix H.
 - 3. Designate limits of each placement and obtain Engineer's review of entire installation prior to proceeding.
- B. Concrete placed against gravel or crushed stone.
 - 1. Prevent loss of water from concrete with a minimum 2 in. layer of material having 25 percent fines passing a No. 4 sieve.
- C. Concrete placed against hardened or existing concrete.
 - 1. Prior to placing fresh concrete against surface of hardened concrete, complete the following:
 - a. Remove all laitance, foreign substances (including curing compound), wash with clean water, and thoroughly wet hardened surface before placing fresh concrete.
 - b. Apply bonding agent at blockouts, cutouts and in locations directed by Engineer.

3.3. PLACEMENT:

- A. Conveying.
 - 1. Convey concrete from mixer to final position as rapidly as practicable without segregation or loss of material.
 - 2. Use only metal or metal-lined chutes with maximum length of 20 ft, having a maximum slope of 1 vertical to 2 horizontal, and a minimum slope of 1 vertical to 3 horizontal.
 - 3. Provide a hopper at the end of long-belt conveyors and chutes not meeting the requirements in 2. above.
 - 4. Conveying by pumping methods shall conform to ACI 304, Chapter 9.
- B. Depositing in Walls.
 - 1. Deposit concrete in a continuous operation until section is completed.
 - 2. Place concrete in approximately horizontal layers 2 ft maximum thickness.
 - 3. Each layer of concrete shall be plastic when covered with following layer.
 - 4. Rate of vertical rise not more than 2 ft per hour unless formwork is designed for higher pressures.
 - 5. Provide placement capacity as necessary to comply with these requirements with construction and other joint locations shown on the Drawings.
 - 6. Maximum height of concrete free fall, 4 ft.
 - 7. Pump concrete or use a tremie having varying lengths for placing concrete in columns and walls to prevent free fall of more than 4 ft.
 - 8. Concrete shall not be dropped through reinforcing steel nor subjected to any other procedure that will cause segregation.
 - 9. Place concrete in wall or column forms at least 24 hours prior to the time concrete or any reinforcing steel is placed in the system to be supported by such walls or columns except as noted below.
 - 10. Do not exceed 6 ft of vertical height for any portion of a wall or column placed monolithically with floor or roof slab.
 - 11. Allow concrete to thoroughly settle before top is finished. Remove all laitance, debris, and surplus water from surfaces at tops of forms by screeding, scraping, or other effective means.
 - 12. Overfill forms wherever top of a wall will be exposed to weathering and after concrete has settled, screed off excess.
 - 13. See section 3-4 C. for preparation of construction joints prior to placing wall concrete.
- C. Depositing in Floor and Roof Slabs.
 - 1. Deposit concrete in a continuous operation until section is completed.
 - 2. Concrete shall be deposited as nearly as practicable to its final position to avoid segregation due to rehandling or flowing.
 - 3. Concrete shall be covered with 6 mil thick plastic 12 ft wide or Burlene, overlapped approximately 1.5 ft, prior to the development of plastic shrinkage cracks, Confilm or other evaporation retarders may be used in lieu of plastic sheeting.
- D. Consolidation

1. During and immediately after placement, thoroughly compact and work around all reinforcements, embedments, and into corners of forms, eliminating all air or stone pockets that may cause honeycombing, pitting, or planes of weakness.
2. Use mechanical vibrators that will maintain at least 9,000 cycles per minute when immersed in concrete.
3. Minimum horsepower per vibrator shall be 1-1/2.
4. Number and type of vibrators shall be as acceptable to Engineer. A spare vibrator will be available at all times in case of mechanical problems.
5. Over-vibrating and the use of vibrators to transport concrete laterally in forms will not be allowed.
6. Vertically insert vibrators at points approximately 2 ft apart and to a depth to penetrate 6 in. into the preceding layer.
7. Vibrate each location for a length of time to obtain adequate consolidation (generally 5 to 15 seconds).

3.4. JOINTS:

- A. Watertight joints.
 1. Use at all locations where water is to be contained, groundwater is to be resisted and as shown on Drawings.
- B. Expansion and contraction (control) joints.
 1. At locations shown on Drawings.
 2. Extend reinforcement continuously through joints, except "Expansion Joints," unless specifically shown on Drawings.
 3. Form joint with felt, ASTM D 2475, where "bond breaker" is indicated.
 4. Flexible joint filler material as indicated in Part 2-3, shall be used in Expansion Joints.
 5. Expansion and contraction joints shall be caulked with a joint sealer as indicated in Part 2-3.
- C. Construction joints.
 1. Provide where shown on Drawings.
 2. Obtain Engineer's approval for proposed locations of construction joints not shown on Drawings or for proposed elimination of construction joints shown on Drawings.
 3. Locate joints to least impair the strength and serviceability of the structure, generally as follows:
 - a. Columns and walls.
 - 1) At underside of beams, girders, haunches, drop panels, slabs, and at floor levels.
 - 2) All haunches and drop panels shall be considered as parts of supported floor or roof and shall be placed monolithically therewith.
 - b. Suspended slabs.
 - 1) At or near mid-span in flat slab construction.

- c. Construction joints in walls, beams, girders, and slabs shall be perpendicular to planes of their surfaces, with expansive rubber waterstops, and shall not be keyed except as shown on Drawings.
- d. Maximum length of wall segments without construction joints shall be 500 ft or as shown on the Drawings.
- 4. The surfaces of concrete to be cast against shall be thoroughly cleaned and all laitance removed. Concrete shall be vibrated adequately to prevent honeycombing at the joint.
- 5. Construction joints shall require bond.
- 6. Joints where indicated on Drawings or where directed by the Engineer to receive an epoxy bonding agent shall have been prepared and the bonding agent applied in accordance with the manufacturer's recommendations prior to placing fresh concrete.

3.5. EMBEDDED ITEMS:

- A. Refer to Concrete Formwork — Section 03 11 03 SP - Part 3-1B.

3.6. FINISHING EXPOSED SURFACES:

- A. Finishing unformed surfaces.
 - 1. Slabs for aprons, slabs-on-grade, and tops of walls.
 - a. Provide surface conforming to proper elevation and contour. Except as noted otherwise on the Drawings, all walks and slabs shall slope 2 percent away from buildings. All other walks, exterior concrete steps, etc. shall be pitched to drain out with a slope of $\frac{1}{4}$ in. per ft. Tops of retaining walls shall be pitched back (into the backfill) 0.25 in. per ft unless designated otherwise by the Engineer. All aggregates shall be completely embedded in mortar by screeding.
 - 1) Screeded surfaces shall be free of surface irregularities.
 - 2) Maximum variation from a plane surface in any 10 ft section shall be $\frac{1}{4}$ in.
 - 2. Coordination of Finishing and Placement.
 - a. Mixing and placing shall be carefully coordinated with finishing. Concrete shall not be placed on the subgrade or forms more rapidly than it can be spread, straight edged, and bull floated. These operations must be performed before bleeding water has an opportunity to collect on the surface.
 - b. To obtain good surfaces and avoid cold joints, the size of placing and finishing crews shall be planned with due regard for the effects of concrete temperature and atmospheric conditions on the rate of hardening of the concrete.
 - c. All flatwork finishers on the project shall have experience and supervised by ACI Certified flatwork finishers.
 - 3. Jointing and Edging.

- a. Joints in slabs shall be located and detailed as indicated on the Drawings and in the Specifications.
 - b. Edge exposed edges of floated or troweled surfaces with a tool having a $\frac{1}{4}$ in. corner radius unless these edges are specified to be beveled.
4. Consolidation.
Concrete in slabs shall be thoroughly consolidated. Internal vibration shall be used in beams and girders of framed slabs and along the bulkheads of slabs on grade. Consolidation of slabs shall be obtained with vibrating screeds, roller pipe screeds, internal vibrators, or other acceptable means. The concrete surfaces shall not be manipulated prior to finishing operations.
5. Finishes.
- a. Unless selection of finishes is made in the Specifications or on the Drawings, the following finishes shall be used, as applicable.
 - 1) Floated Finish - Use for tank floor and roof, walls, footings, pile caps, etc.
 - 2) Troweled Finish - Use for floors in finished areas and where called for on Drawings.
 - 3) Broom Finish - Use for concrete stairs, landings, sidewalks, concrete path, curb, and gutters.
 - 4) Raked Finish - Use for slabs to receive topping or secondary concrete
 - b. The following finishes shall be utilized on this project unless specified or detailed otherwise.
 - 1) Floated Finish.
After the concrete has been placed, consolidated, struck-off, and leveled by bull floating, the concrete shall not be worked further until ready for floating. Floating shall begin when the water sheen has disappeared and/or when the mix has stiffened sufficiently to permit the proper operation of a power-driven float. The surface shall then be consolidated with power-driven floats of the impact type, except in thin sections, such as pan slabs, which shall be floated by hand. Hand floating with wood or cork-faced floats shall be used in locations inaccessible to the power-driven machine. Trueness of surface shall be rechecked at this stage with a 10-foot straightedge applied at not less than two different angles. All high spots shall be cut down and all low spots filled during this procedure to produce planes checking true under the straightedge in any direction, with tolerances not exceeding $\frac{1}{4}$ in. in 10 ft. The slab shall then be refloated immediately to a uniform, smooth, granular texture.
 - 2) Troweled Finish.
Where a troweled finish is specified, the surface shall be finished first with impact power floats, as specified above

where applicable, then with power trowels and finally with hand trowels. The first troweling after power floating shall be done by a power trowel and shall produce a smooth surface that is relatively free of defects, but which may still contain some trowel marks. Additional troweling shall be done by hand after the surface has hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand troweling operations. The finished surface shall be free of any trowel marks and shall be uniform in texture and appearance, with tolerances not exceeding ¼ in. in 10 ft. On surfaces that support floor coverings, any defects of sufficient magnitude to show through the floor covering shall be removed by grinding.

- 3) Broom Finish.
Slabs shall be given a coarse transverse-scored texture by drawing a broom across the surface. This operation shall follow immediately after bull floating operations and hand floating as required to close the surface. Provide a uniform abrasive texture of constant color. On paths, broom at right angles to normal traffic direction.

3.7. REPLACEMENT, REPAIRING AND PATCHING OF DEFECTIVE CONCRETE:

- A. Removal and replacement of defective concrete
 1. After forms have been removed, any concrete that is not formed as shown on the Drawings, is out of alignment or level beyond the required tolerance, shows a defective surface that cannot be properly repaired or patched, or cannot be shown to prevent water migration through concrete surfaces or joints, shall be removed and replaced at the Contractor's expense.
 2. Liquid retaining concrete walls, slabs, beams, etc., cannot have any honeycombing, cold joints, cracks greater than 0.004 in. wide, or leakage of water through the concrete thickness or joints. If in the opinion of the Engineer the honeycombing, cold joints, cracks, or leakage are excessive, the Contractor shall be required to remove the complete concrete segment and replace it. Where minor honeycombing, cold joints, cracks or leakage occurs, it shall be repaired as indicated in Part 3-7.B and C below.
- B. Repair of tie holes, blockouts, cutouts and defective concrete.
 1. Immediately after form removal, repair, to the satisfaction of the Engineer, all repairable surface defects, including tie holes, in concrete surfaces. In all cases, repair work shall be completed within 24 hours of removal of the forms.

2. Replace, to satisfaction of Engineer, within 48 hours after adjacent forms have been removed, all other honeycombed and defective concrete areas that cannot be immediately repaired as noted in item 1 above.
 3. Cut out and remove to sound concrete, with edges square-cut to avoid feathering, all honeycombed or otherwise defective concrete.
 4. Repair work shall conform to ACI 301 and these specifications. At all blockouts, tie-holes and cutouts, after being thoroughly cleaned, apply an epoxy-bonding agent, and fill with non-shrink grout, as specified in the materials section of this specification. Color shall be added to match surrounding concrete.
 5. Perform in a manner that will not interfere with thorough curing of surrounding concrete.
 6. Adequately cure all repair work.
- C. Repair of cracks and minor honeycombed areas.
All cracks, minor honeycombed concrete, or other areas of apparent leakage, including wet spots on the wall, shall be sealed with Epoxy Sealant injection or other acceptable means so that the concrete is watertight as defined in Specification Section 02676 "WATERTIGHTNESS TESTING."

3.8. FINISHING FORMED SURFACES:

- A. Finishing.
1. Rough form finish - All surfaces not exposed to view such as surfaces in contact with earth.
 - a. Chip off all fins and other surface projections greater than ¼ in. high.
 - b. Fill all tie holes and repair and patch all defects.
 2. Smooth form finish - All exposed surfaces not generally exposed to view including interior surfaces of tank.
 - a. Use form facing to produce a smooth, hard uniform surface.
 - b. Keep number of seams to a minimum.
 - c. Remove all fins and projections.
 - d. Clean, coat, and fill all tie holes.
 - e. Repair and patch all defects.

3.9. CURING:

- A. General.
1. Freshly deposited concrete shall be protected from premature drying and excessively hot or cold temperatures and shall be maintained without drying at a relatively constant temperature for the period of time necessary for the hydration of the cementitious materials and proper hardening of the concrete. A list of all intended curing methods including a description of materials shall be submitted to the Engineer for review.
 2. Initially, the concrete temperature shall be maintained at or above 70 F. for 3 days or at or above 50 F. for 5 days. Continue curing as required to

achieve the specified 28-day strength. See Part 1-5 Job Conditions for additional information.

3. Use membrane-curing compound as noted below.
- B. Membrane curing compound (conforming to ASTM C 309).
 1. Shall be used prior to placement of plastic sheeting on concrete floor and roof slabs, walls, and other miscellaneous concrete areas where acceptable to Engineer.
 2. Spray-apply in 2 coats perpendicular to each other at coverage recommended by manufacturer.
 3. Cover unformed surfaces with curing compound within 30 minutes after final finishing.
 4. Apply curing compound immediately to formed surfaces if forms are removed before end of specified curing period. Curing compound sprayed in tie holes is to be cleaned out before patching tie holes. Forms may be left in place for all or part of the curing period; wood forms shall be kept wet.
 5. Protect compound against abrasion during curing period.
- C. Film Curing (conforming to ASTM C 171).
 1. Concrete placed early in the concrete placing operation shall not be allowed to dry out. Apply Membrane Curing Compound, or other material acceptable to the Engineer, as noted above prior to placing the polyethylene film or other coverings.
 2. Begin as quickly as possible after initial set of concrete.
 3. Cover surfaces completely with polyethylene sheeting.
 4. Overlap edges for proper sealing and anchorage.
 5. Cover joints between sheets with dunnage as required to prevent displacement due to wind or other factors.
 6. Promptly repair all tears, holes, and other damage.
 7. Anchor continuously all edges and anchor surface as necessary to prevent billowing.

3.10. QUALITY CONTROL:

- A. Concrete tests.
 1. Shall be in accordance with the requirements of ACI 301, except as noted or modified in this Section. Test specimens shall be taken by an ACI Certified Concrete Field Testing Technician - Grade 1 in accordance with the "Standard Method of Making and Curing Concrete Test Specimens in the Field," ASTM C 31.
 - a. Strength test.
 - 1) Mold and laboratory cure seven cylinders from each sample.
 - 2) Test two cylinders at 7 days per ASTM C 39. Test two cylinders at 28 days for acceptance. Keep the remaining as a spares or to be tested as directed by Engineer.

3) The spare cylinders for each sample may be eliminated after the first several concrete placements of each type of concrete if, in the opinion of the Engineer, test results are consistent and within specifications.

b. Minimum samples.
Collect the following minimum samples for each 28-day strength concrete used in the work for each day's placing:

<u>Concrete Quantity</u>	<u>Number of Samples</u>
50 yds ³ or less	one
50 to 100 yds ³	two
100 yds ³ or more	two plus one sample for each additional 100 yds ³

c. Slump test.

- 1) Conduct test for each strength test sample and whenever consistency of concrete appears to vary.
- 2) Slump tests shall be made using "Method of Test for Slump of Portland Cement Concrete" (ASTM C 143).

d. Air content.

- 1) Conduct test from one of first three batches mixed each day and for each strength test sample.
- 2) Samples indicating low air contents by the pressure method air content tests in accordance with ASTM C 231 shall be verified by the gravimetric method, ASTM C 138, and the volumetric method, ASTM C 173, before adding additional air entraining admixture in the field.

2. The Contractor shall provide the following to the Owner and the Testing Agency at no additional cost to the Owner:

- a. Incidental labor required to facilitate testing.
- b. Minimum one day's advance notice when concrete is to be placed.
- c. Storage facilities for concrete test cylinders; including, when necessary, a specially prepared box with high-low thermometer and thermostatically controlled heating devices in accordance with Section 9.2 of ASTM C 31 for storage of the cylinders for the first 24 hours after molding.
- d. Materials, samples, and access to materials as required for testing.
- e. The use of testing services shall in no way relieve the Contractor of his responsibility to furnish materials and construction in full compliance with the Drawings and Specifications.

B. Acceptance of Concrete.

1. If the early strength tests fall below the early strengths deemed necessary to achieve the specified 28-day strength, the Engineer shall have the right to require conditions of temperature and moisture necessary to secure the required strength. The Engineer may also require pull out tests in accordance with ASTM C 900 or core tests in accordance with ASTM C 42.

2. Strength level of concrete will be considered satisfactory so long as average of all sets of two consecutive strength test results equals or exceeds specified 28-day strength and no individual strength test result falls below the specified strength by more than 500 psi.
- C. Failure of Test Cylinder Results.
1. Upon failure of the 28-day test cylinder results, Engineer may require Contractor at his expense, to obtain and test cored samples from area in question.
 2. Concrete will be considered adequate if average of three core tests is at least 85 percent of, and if no single core is less than 75 percent of the specified 28-day strength.
 3. Upon failure of the core test results, Engineer may require Contractor, at his expense, to perform load tests as specified in ACI 318, Chapter 20.
 4. In the event an area is found to be structurally unsound, the Engineer may order removal and replacement of concrete as required. The cost of the pullout or core tests, and the load test and the structural evaluation shall be borne by the Contractor.
 5. Fill all core holes as specified for repairing defective concrete.

3.11. SPECIAL TESTING REQUIREMENTS:

- A. Further concrete testing, in addition to Quality Control Testing and testing for proposed mix designs, may become necessary during the project. Testing shall be provided under the conditions stated in each specification section and shall be in accordance with the requirements of ACI 301 and this specification. Refer to Parts 3-10B and 3-10C for acceptance criteria and procedures upon failure of tests.
- B. In all cases, the Contractor shall provide the Owner and the testing agency, at no additional cost to the Owner, with the items listed in Part 3-10.A.2.
- C. Sampling and Test Groups.
1. When job cured cylinders are used, samples shall be obtained as specified in Section 03300, Parts 3-10A.1.a, 3-10A.1.b and 3-10A.1.c, unless directed otherwise by the Engineer.
 2. When core tests are used, samples shall be obtained in accordance with ASTM C 42 and as directed by the Engineer.

- END OF SECTION

03 70 00 SP
WATERTIGHTNESS TESTING OF AWWA D115 TANK

1. GENERAL

1.1. DESCRIPTION:

- A. Furnish all labor, equipment, and materials necessary to test the water tanks for watertightness.

2. PRODUCTS

2.1. MATERIALS:

Water, clean and free of deleterious substances.

3. EXECUTION

3.1. PREPARATION:

After construction of the reservoir or tank has been completed, and before backfilling, the floor and inside of the walls shall be broom-cleaned. The floor shall be squeegeed of curing water and washed with clean water. After the sweeping and the removal of all debris, any cracks greater than 0.004 in. wide and joints shall be properly sealed in accordance with provisions of Section 03 30 11 SP, 3-7. Completely hose down the interior surfaces of the reservoir with water under pressure.

3.2. TESTING:

Watertightness testing shall be performed. Two tests are required. The first test shall be made on the overall watertightness of the tank. The second test shall be made on the visible surfaces of the tank.

A. Overall Watertightness Testing

- 1. Fill to the overflow and allow tank or basin to stand full for at least 24 hours. During the first 24 hours, the surface of the water may drop, and shall be refilled to the overflow.
- 2. The water level elevation shall be determined by using a surveyor's level and level rod or other acceptable means. Measure the drop in water level over the next 5 days to determine the water volume loss for comparison with the acceptance criteria. Floating "evaporation and precipitation pans" shall be used to remove these effects from the test. The liquid loss for each period of 24 hours shall not exceed 0.000125 of the tank capacity (or height), which shall be translated to the nearest 1/16 in. in the 5-day period.

B. Visible Surface Testing

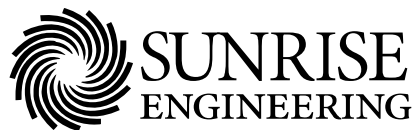
Wet spots on the exterior wall surface or flowing water on the wall base shall not be permitted. Wet spots are defined as spots where moisture can be picked up on a dry hand. Wet spots shall be repaired in accordance with Section 03 30 11 SP, Part 3-7.

- C. If the watertightness testing fails to meet the above requirements, the Engineer may require the reservoir or tank to be drained, repaired, and again tested for watertightness.

- END OF SECTION -

DIVISION 5

METALS



05010.1 GENERAL

This section of the Specifications covers metals and metal work required to furnish, fabricate, and to install the following nonexclusive list of items:

- Aluminum and miscellaneous nonferrous metals
- Anchors and anchor bolts
- Bolts
- Cast-iron frames and covers
- Grating and frames
- Ladders
- Louvers
- Manhole frames and covers
- Metal roof decking
- Miscellaneous metal items shown on the Plans or specified
- Miscellaneous structural steel
- Pipe handrails, pipe sleeves, inserts, and chains
- Platforms
- Sheet metalwork
- Special supports, hangers, and anchors
- Stairs and treads
- Steel lintels
- Supports for mechanical equipment
- Tread plates and frames

05010.1.2 RELATED WORK

Not used.

05010.1.3 SUBMITTALS

Certified copies, in duplicate, of mill tests or reports from a recognized commercial laboratory shall be furnished when requested as to the chemical, tensile, and bending properties of each shipment of structural metal or part thereof having common properties. All tests and analyses shall be made in accordance with the applicable ASTM Specification.

05010.1.4 DEFINITIONS

Not used.

05010.2 MATERIALS**05010.2.1 ALUMINUM**

05010.2.1.1 SHEET ALUMINUM - Except as otherwise specified or indicated on the Plans, sheet aluminum shall be alloy 50050H14 conforming to the requirements of ASTM B 209 and shall be not less than 0.025 inch in thickness.

05010.2.1.2 STRUCTURAL ALUMINUM - Structural aluminum shall be 6061-T6, and extruded aluminum shall be 6063-T42.

Aluminum shapes and appurtenant materials shall conform to the requirements of ASTM B 221 and ASTM B 308 and shall be of aluminum alloy known commercially as 6061-T6. Materials not otherwise specified shall conform to the latest applicable Specifications of ASTM.

05010.2.1.3 BOLTS - All bolts for bolting aluminum shall be Type 304 or 316 stainless steel of sizes indicated on the Plans.

05010.2.2 STEEL

05010.2.2.1 SHEET STEEL - Galvanized sheet iron or steel shall conform to ASTM A 525, 1.25-ounce coating; black steel to ASTM A 569.

05010.2.2.2 STRUCTURAL STEEL – Structural steel shall be as follows:

- Unless otherwise specified, structural steel shall conform to ASTM A 36.
- Cast iron shall conform to ASTM A 48, Class 40B.
- Galvanized structural steel or iron shall be “hot dipped” galvanized after fabrication. Electro-galvanizing shall not be used unless specified otherwise.
- All structural steel shall be delivered free from mill scale, rust, or pitting.
- Items not galvanized or protected by a shop coat of paint shall be protected from the weather until erection and painting.

05010.2.2.3 STAINLESS STEEL - Stainless steel, unless specifically specified or indicated on the Plans otherwise, shall be Type 316 or Type 304, nonmagnetic.

05010.2.2.4 STEEL PIPE - Steel pipe shall conform to ANSI B 36.10, Table I.

05010.2.2.5 BOLTS - High tensile bolts shall conform to ASTM A 325.

05010.2.2.6 OTHER ITEMS

Other structural and miscellaneous metal items shall be as indicated on the Plans or as specified elsewhere.

05010.3 CONSTRUCTION (FABRICATION) REQUIREMENTS

05010.3.1 GENERAL

All structural or foundry items shall be carefully fabricated to true dimensions without warp or twist. Welded closures shall be neatly made; and where weld material interferes with fit or is unsightly in appearance, it shall be ground off smooth.

05010.3.1.1 INSTALLATION - Each structural item shall be installed true to level, plumb, alignment, and grade with all parts bearing or fitting the structure or equipment for which it is intended accurately and securely. It shall not be permitted to cock out of alignment, re-drill, reshape, or force to fit any fabricated item. It is the Contractor’s responsibility to place anchor bolts or other anchoring devices accurately and to make any surfaces, which bear against structural items smooth and true to level to preclude the necessity of any springing, re-drilling, or reshaping.

- 05010.3.1.2 SPECIAL ALIGNMENT - Pipe railings, posts, and structural items needing a special alignment to preserve straight, level, even, smooth lines shall be rigidly supported and braced and kept braced until concrete, grout, or dry pack cement mortar has hardened for a period of not less than 48 hours.
- 05010.3.1.3 FIT - The Contractor shall be responsible for the correct fitting of all metalwork in the field. The Contractor shall take all measurements necessary to properly fit its work in the field, and it shall be governed by and be responsible for these measurements and the proper working out of all details.
- 05010.3.1.4 WELDING – General welding procedures are as follows (see also Subsections below):
- The Contractor shall notify the Engineer at least 24 hours before starting shop or field welding.
 - A welding inspector may check the materials, the equipment, and the qualifications of the welders.
 - The inspector may use gamma ray, magnetic particle, dye penetrant, trepanning, or any other aid to visual inspection which it may deem necessary to be assured of the adequacy of the welding.
 - The costs of any tests and all re-tests on defective welds shall be borne by the Contractor. Cost in connection with qualifying welders shall also be borne by the Contractor.
 - The cost of tests on sound welds will be borne by the Owner.
 - Welders doing unsatisfactory work shall be removed or may be required to pass qualification tests again.
- 05010.3.1.5 MISCELLANEOUS METALWORK - Where anchors, connections, or other details of miscellaneous metalwork are not definitely shown or specified, its material, size, form, attachment, and location shall conform to best practice.
- 05010.3.1.6 HAZARDOUS PROJECTIONS - Sharp or hazardous projections shall be rounded off and ground smooth.
- 05010.3.1.7 CHIPS AND DEBRIS - All chips and other debris lodged between contacting surfaces shall be removed before assembly.
- 05010.3.2 ALUMINUM
- 05010.3.2.1 STRUCTURAL ALUMINUM
- The Contractor shall furnish and install all structural aluminum items in accordance with the Plans and as specified. It shall provide all supplementary parts necessary to complete each item even though such work is not definitely covered by the Plans and Specifications. Its size, form, attachment, and location shall be such as to conform to the best of current practice.
- 05010.3.2.2 LAYOUT ON ALUMINUM - Hole centers may be center punched and cutoff lines may be punched or scribed. Center punching and scribing shall not be used where such marks would remain visible on the surface of the fabricated material.

When critical dimensions exist, a temperature correction shall be applied in the layout as necessary. The coefficient of expansion shall be taken as 0.000013 per degree F.

05010.3.2.3 CUTTING AND DRILLING ALUMINUM – Aluminum may be cut and drilled as follows:

- Material 1/2 inch thick or less may be sheared, sawed, or cut with a router. Material more than 1/2 inch thick shall be sawed or routed.
- Cut edges shall be true, smooth, and free from excessive burrs or ragged breaks.
- Edges of plates carrying calculated stresses shall be planed to a depth of 1/4 inch. Sawn or routed edges will be acceptable when the finish is of equal quality to a planed edge.
- Re-entrant cuts shall be avoided wherever possible. If used, they shall be filleted by drilling prior to cutting.
- Rivet or bolt holes may be punched or drilled to finished size before assembly.
- The finished diameter of holes for unfinished bolts shall be not more than 1/16 inch larger than the nominal bolt diameter.
- All holes shall be cylindrical and perpendicular to the principal surface. Holes shall not be drifted in such a manner as to distort the metal.
- Flame cutting of aluminum alloys is not permitted.

05010.3.2.4 ALUMINUM FORMING AND ASSEMBLY - Structural aluminum material may not be heated except in forming operations where material may be heated to a temperature not exceeding 400 degrees F for a period not exceeding 30 minutes to facilitate bending. Such heating shall be done only when proper temperature controls and supervision are provided to insure that the limitations on temperature and time are carefully observed.

05010.3.2.5 WELDING ALUMINUM - This Specification shall apply to both field and shop welding operations. The general recommendations and regulations shown in the American Welding Society Specifications D1.1, "Structural Welding Code," apply to 6061-T6 structures. Detail requirements for welding aluminum alloy 6061-T6 are given as follows:

- Filler metal for welding shall be aluminum alloy welding rods conforming to the requirements of AWS A 5.10 and shall be AWS classification ER 4043, ER 5154, ER 5254, ER 5183, ER 5356, or ER 5556.
- The welding process and welding operators shall both meet a qualification tests. The method of qualification shall conform to the method described in the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications," Part B. Aluminum alloy 6061-T6 shall be used for the qualification test plates. Operators shall be qualified on the basis on bend tests and a fillet weld soundness test.
- Dirt, grease, forming or machining lubricants, or any organic materials shall be removed from the areas to be welded by cleaning with a suitable solvent or by vapor degreasing. Additional operations to remove the oxide coating just prior to welding are required when the inert gas tungsten arc welding method is used. This may be done by etching or by scratch brushing. The oxide coating may not need to be removed if the welding is done with the automatic or semi-automatic inert gas shielded metal arc.

- Suitable edge preparation to assure 100 percent penetration in butt welds shall be used. Oxygen cutting shall not be used. Sawing, chipping, machining or shearing may be used.
- Any welding of aluminum shall be done using a nonconsumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG). No welding process that requires the use of a welding flux shall be used unless prior approval has been obtained from the Engineer. Preheating for welding is permissible provided the temperature does not exceed 400° F for a total time of 30 minutes.
- Welding of any structure which is to be anodized shall be done using filler alloy rods that will not discolor when anodized. ER 5154, ER 5254, ER 5183, ER 5356, or ER 5556 filler alloy rods shall be used.

05010.3.2.6 PROTECTION OF ALUMINUM SURFACES - Aluminum surfaces to be placed in contact with wood, concrete, masonry, or dissimilar metals other than stainless steel shall be protected as specified in the appropriate sections of Division 9 – Finishes.

05010.3.2.7 BOLTING - Where aluminum comes in contact with steel it shall be bolted with stainless steel bolts and separated or isolated from the steel with neoprene gaskets or washers or as specified in Division 9.

05010.3.3 STEEL

05010.3.3.1 STRUCTURAL STEEL – The following shall apply:

- The Contractor shall furnish and install all structural steel items in accordance with the plans and as specified herein.
- The Contractor also shall provide all supplementary parts necessary to complete each item even though such work may not be specifically covered by the Plans and Specifications.
- Wherever applicable, all fabrication and erection of steel items shall conform to AISC “Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings” except as the same may be modified by applicable building codes, the General Conditions, and these Specifications.

05010.3.3.2 WELDING OF STEEL – Both the general recommendations and regulations shown in the American Welding Society Specifications D1.1, “Structural Welding Code,” as well as the detail requirements in those specifications apply to welding of steel structures. Welding of steel shall adhere to the following:

- All welding of steel under this section shall be done by welders who have a current AWS certificate for the type of welding to be done by the welder.
- All welding of structural steel type ASTM A 36 shall be done using mild steel covered Arc Welding Electrodes conforming to ASTM A 233, Series E70, or shall be done using Electrodes and Fluxes for Submerged Arc Welding conforming to ASTM A 558, Classification F70-XXXXX, where XXXXX refers to any electrode referred to in ASTM A 558.
- Welding of stainless steels shall be done with electrodes and techniques as recommended in Welded Austenitic Chromium - Nickel Stainless Steels - Techniques and Properties as

published by the International Nickel Company, Inc., New York, New York. All welds shall be full penetration welds, unless specified otherwise.

05010.3.3.3 PROTECTION OF STEELWORK - The Contractor shall paint steel and miscellaneous ferrous metal items as specified in the appropriate sections of Division 9-Finishes.

05010.3.4 DUCTWORK

05010.3.4.1 DESIGN AND FABRICATION - Ducts shall be fabricated of aluminum or galvanized steel sheets with gauges of sheet metal, joint types, reinforcing, bracing, supporting, fabricating, installing, and other requirements in accordance with Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems of the Sheet Metal and Air Conditioning Contractors National Association, Inc. Ducts shall be designed for the appropriate pressure type as shown in the above mentioned Duct Manual. Details on the Plans in some cases call for sheet metal thicknesses greater than called for in the Duct manual. Sheet metal shall conform to whichever requirement calls for the greater thickness. Aluminum ducting shall be not less than 0.063 inches thick.

05010.3.4.2 HANGERS - Ducts shall be supported on both sides at all changes in direction and at not greater than eight foot intervals by suitable hangers as specified herein or as detailed on the Plans. For galvanized ducting, hangers for ducts 12-inch by 24-inch or smaller shall be galvanized sheet metal straps not lighter than 18-gauge by one inch secured to the structure by one 5/16-inch bolt and to the duct by not less than two No. 10 sheet metal screws or 3/16-inch stove bolts. Hangers for ducts larger than 12-inch by 24-inch shall be galvanized steel straps or rods not less than 0.13 square inches in net cross section, secured to the structure by a Grinnell Figure 152, Size 2, concrete insert, or approved equal, and to a duct pocket or reinforcing angle by two 1/4-inch stove bolts. For aluminum ducting, supports shall be equivalent to supports for galvanized ducting except that all fasteners, fittings, and shafting shall be stainless steel.

05010.3.4.3 FLEXIBLE CONNECTIONS - Where blowers or equipment containing blowers or other machine elements, which may cause vibration, are connected to ducts or housing, such connections shall be by means of flexible connections. These flexible connections shall be airtight at the pressures encountered and be flame proof and water proof. The flexible material shall be equivalent to 14 ounce canvas.

05010.4 METHOD OF MEASUREMENT

Not used.

05010.5 BASIS OF PAYMENT

Not used.

05050.1 DESCRIPTION

This section covers a generic list of miscellaneous metals specifications.

05050.1.1 RELATED WORK

Not used.

05050.1.2 SUBMITTALS

Not used.

05050.1.3 DEFINITIONS

Not used.

05050.2 MATERIALS**05050.2.1 LADDERS AND METAL STAIRS**

All ladders shall be safety ladders conforming to OSHA standards. All ladders and stairways supplied to the project shall be of one manufacturer. All stair and ladder wells shall be adequately guarded, and all stairs shall have handrails as specified or shown on the Plans.

Ladders shall be secured to the supporting surface by bent plate chips providing not less than 7 inches between the supporting surface and center of rungs. If exit from the ladder is forward, over the top rung, side rails shall be extended not less than 3-feet-3 inches above, and returned to the landing. If exit from the ladder is to the side, the ladder shall extend not less than 5-feet 6-inches above the landing and be rigidly secured at the top.

05050.2.2 ALUMINUM LADDERS

Aluminum ladders shall be made of 6063-T5-aluminum alloy, of welding construction. Rungs shall be not less than 1-inch square bar with 1/8-inch grooves in the top and redivided edges. Side rails shall be no lighter than 3 inches by 3/8 inches. Ladders shall be of the size, shape, location, and details indicated on the Plans. Ladders greater than 20 feet in height shall have standard ladder cages designed in accordance with State and OSHA requirements. All aluminum surfaces, which will be in contact with concrete, shall be coated as specified in Division 9.

05050.2.3 ALUMINUM STAIRWAYS

Aluminum stairways shall be fabricated and installed as shown on the Plans. Stairway stringers shall be fabricated of aluminum alloy 6061-T6. Treads shall be aluminum as specified below. Handrail shall be fabricated of aluminum pipe as specified under aluminum handrail.

Stair treads shall be aluminum of the sizes called for on the Plans, and shall be of the same type and make as called for under GATING. All fasteners shall be of Type 304 or 316 stainless steel.

Stair treads shall be furnished with cast abrasive type safety nosing.

05050.2.4 ARCHITECTURAL AND MISCELLANEOUS SHEET METAL

Sheet metal flashing and counterflashing shall be installed as indicated on the Plans. Galvanized steel or anodized aluminum flashing shall be used when indicated and specified on the Plans.

Unless otherwise indicated flashing shall be 0.025-inches thick. The aluminum flashing shall receive a 215-R1 anodic finish after fabrication as indicated on the Plans. Exposed edges shall be folded back 1/2-inch to provide stiffness. Except as otherwise indicated and specified on the Plans, counterflash shall be provided over all base flashings.

Unless specifically noted, galvanized steel flashing shall be used in contact with structural steel and anodized aluminum flashing shall be used in contact with structural aluminum. This shall be done to protect against dissimilar metal action.

Surfaces to which sheet metal is to be applied shall be even, smooth, round, thoroughly clean and dry, and free from all defects that might affect the application. All cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades shall be performed under this section. All accessories or other items essential to the completeness of this sheet metal installation, though not specifically shown or specified, shall also be provided under this section. Nails, screws, and bolts shall be of the types best suited for the intended purpose and shall be of a composition that will not support galvanic action in the installation. Where sheet metal abuts into adjacent materials, the juncture shall be executed in a manner satisfactory to the Engineer.

Sheet metal items not covered elsewhere shall be as indicated on the Drawings and as required to provide a watertight installation. Formed sheet metal for metal covered work shall accurately reproduce the detail and design shown and profiles, bends, and intersections shall be sharp, even, and true.

05050.2.5 ALUMINUM SHEET METAL WORK

Except as otherwise specified or indicated on the Plans, sheet aluminum shall be alloy 5005-H14 conforming to the requirements of ASTM B 209 and shall be not less than 0.025 inch in thickness and extruded aluminum shall be 6063-T42.

05050.2.6 MISCELLANEOUS STRUCTURAL STEEL

Miscellaneous steel items not specified herein shall be as shown on the Plans or specified elsewhere and shall be fabricated and installed in accordance with the best practices of the trade.

05050.2.7 LINTELS

Lintels for masonry construction shall be structural steel beams or angles, fabricated as indicated on the Plans.

05050.2.8 SUBMERGED ASSEMBLY BOLTS

Assembly bolts for wood baffles, collectors, and other assemblies in areas where stainless steel anchor bolts would be required shall be stainless steel bolts Type 304 or 316.

05050.2.9 ANCHOR BOLTS AND INSERTS

Wherever feasible, anchor bolts shall be cast in place when concrete is placed.

All anchor bolts and concrete anchors embedded in concrete shall be accurately spaced with bolts truly normal to the surfaces from which they project. Type 304 or Type 316 stainless steel anchor bolts and nuts shall be used under these circumstances:

- Any time they are submerged in water.

- In the case of structures customarily containing water, placed in walls, ceilings, or overheads, even if above water level.
- In the dry side of water bearing walls.
- Where securing aluminum to steel or concrete.

Anchor bolts not required by above conditions to be of stainless steel, may be of carbon steel conforming to ASTM A 307 or ASTM A 36. Carbon steel anchor bolts in the following locations shall be hot-dip galvanized.

- Anchor bolts exposed to the weather.
- In electrical manholes or pull boxes.
- In tunnels, passageways, galleries, vaults, or rooms below grade or enclosed in part by water bearing walls.

In anchoring machinery bases subject to heavy vibration, two nuts shall be used, one serving as a locknut. In all cases where steel anchor bolts are used, a liberal coating of nonoxidizing wax shall be applied to the threads before screwing on nuts.

All bolts, when indicated for future use, shall be first coated thoroughly with nonoxidizing wax, followed by turning nuts down to the full depth of thread. Exposed thread shall then be neatly wrapped with a waterproof polyvinyl tape.

05050.2.10 **INSTALLATION**

Anchor bolts shall be embedded not less than 12 diameters. Where shown on the Plans, anchor bolts shall be set in metal sleeves having an inside diameter approximately 3 times the bolt diameter and not less than 12-bolt diameters in length. Sleeves shall be filled with grout when the machine or other equipment is grouted.

05050.2.11 **CONCRETE ANCHORS**

Concrete anchors, where indicated on the Plans or specified, shall mean drilled in place anchors with integral anchor bolts. Concrete anchors shall be Phillips "Wedge Anchors" with integral anchor bolts, or Expansion Products Company "Wej-It" concrete anchors with integral anchor bolts, or approved equal.

The material of each concrete anchor, including its integral anchor bolt, shall be the same material as would be required, under these Specifications, for anchor bolts in the same location that the concrete anchor is to be used.

Concrete anchors shall have the following minimum embedment lengths:

EMBEDMENT OF CONCRETE ANCHORS

Size	Embedment Length
3/8"	1-1/2"
1/2"	2-1/4"
5/8"	2-3/4"
3/4"	3-1/4"

If Wej-It expansion anchors are used they shall have the following minimum embedment length:

WEJ-IT ANCHORS

Size	Embedment Length
1/4"	1-1/2"
1/2"	5"
5/8"	5"
3/4"	5"

Anchor bolts, of the same material and size as required for the specified concrete anchors, may be cast in the concrete in lieu of using concrete anchors. Embedment of bolts in concrete shall be not less than 12-bolt diameter plus a standard hook.

No cast iron, lead cinch, or slug-in anchors will be permitted for use.

05050.2.12 **MISCELLANEOUS CAST IRON**

All castings shall be tough, gray iron, free from cracks, holes, swells, and cold shuts, and be of workmanlike finish, and shall conform to the Standard Details and with the ASTM Specification Designation A 48, Class 40 B. The quality shall be such that a blow from a hammer will produce an indentation on a rectangular edge of the casting without flaking the metal. Before leaving the foundry, all castings shall be thoroughly cleaned and subjected to a hammer inspection, after which they shall receive a coating of coal-tar pitch varnish in such a manner as to form a firm, tenacious coating.

05050.2.13 **MANHOLE FRAMES AND COVERS**

Manhole frames and covers shall be made from a superior quality gray iron, conforming to the requirements of ASTM A 159, Class G3000, or ASTM A 48, Class 30-B. Frames and covers shall have horizontal and vertical bearing surfaces machined to fit neatly, and the cover shall bear firmly in the frame without rocking and shall be easily removable. Frames and covers shall be heavy-duty traffic type designed for H-20 loading and shall have a combined set weight of at least 265 pounds.

Frames shall have a clear inside opening of 24 inches diameter and shall be of the bottom flange type. Frame height shall be approximately 4½" and bottom flange outside diameter shall be approximately 32 inches.

Covers shall have a skid resistant grid pattern design as recommended ASTM publication STP326.

The elevations at which manhole frames and covers are to be set shall conform to the requirements set forth on the Plans, but in all cases shall be governed by the Engineer in the field. Where the cover is in existing pavement or in the traveled way of the existing road shoulder, it is to be placed flush with the existing surface. Where the structure is outside the limits of the traveled shoulder but not in the roadside ditch, it should be placed 1/10 foot or more above the existing ground surface. Where the manhole cover falls in the existing roadside ditch or right of way, it is to be placed approximately 1-1/2 feet above the existing ground surface or as directed by the Engineer. Manhole frames shall be set at the required grade and shall be securely attached to the top precast manhole shaft unit. After the frames are securely set in the place provided herein, covers shall be installed and all necessary cleaning and scraping of foreign materials from the frames and covers shall be accomplished to ensure a fine satisfactory fit. All costs of setting and securing manhole frame and cover sets in place as herein provided, including all necessary concrete work shall be considered as included in applicable contract unit prices and no additional allowance will be made therefor.

Cast lettering on manhole covers shall be as shown on the Plans. Shop drawings of all manhole rings and covers shall be submitted to the Engineer.

05050.2.14 CAST IRON PRESSURE MANHOLE FRAME AND COVER

The Contractor shall furnish and install, ready for use as indicated on the Plans and as specified herein, rectangular pressure manholes and covers. Each pressure manhole shall have a clear opening of 18" X 30". The pressure plate shall be flat on top and shall not be less than 1/2 inch thick steel and fastened with 316 stainless steel studs and stainless steel nuts. A 1/8-inch thick neoprene gasket shall be supplied between the frame and pressure plate. Lifting shall be provided with a watertight pickhole. The frame shall be a seal-type with flanges at the base and at the top.

05050.2.15 MISCELLANEOUS ALUMINUM

Structural and other metal items fabricated from aluminum, not covered separately herein shall be fabricated in accordance with the best practices of the trade and shall be field assembled by riveting or bolting with no welding or flame cutting permitted except as approved by the Engineer.

05050.2.16 ALUMINUM STAIR NOSING

Stair nosings shall be installed on all treads of all concrete stairs including the top tread of the upper slab. Stair nosings shall be aluminum abrasive cast nosings with aluminum oxide granules integrally cast into the metal forming a permanent nonslip long wearing surface. The nosings shall be Type 101 Stair Tread by Wooster Products, Inc., Spruce Street, Wooster, Ohio 44691, Type A stair treads by American Abrasive Metals Company, or approved equal. The treads shall have integrally cast anchors. Stair nosings shall be cast in fresh concrete and shall be flush with the tread and riser faces. Stair nosing shall be coated with zinc chromate primer in accordance with the provisions of Division 9. Screws shall be 304 or 316 stainless steel.

05050.2.17 MANHOLE STEPS

Manhole steps shall consist of 3/4-inch diameter stainless steel or polyethylene rungs. Rungs shall extend 7-inches from the face of the wall to which they are anchored and shall have a minimum clear width of 16-inches. Rungs shall be designed such that the foot cannot slide off the end. Distance between rungs shall be 12-inches. Rungs shall be hook anchored into walls a minimum of 6-inches.

05050.3 CONSTRUCTION REQUIREMENTS

Not used.

05050.4 METHOD OF MEASUREMENT

Not used.

05050.5 BASIS OF PAYMENT

Not used

05100.1 DESCRIPTION

05100.1.1 Includes furnishing and installing galvanized steel, extruded aluminum, or fiberglass bar grating for commercial or industrial floors and walk ways as shown on the Drawings and in accordance with the requirements described herein.

05100.1.2 RELATED WORK

Not used.

05100.1.3 SUBMITTALS

The Contractor shall provide complete information, which includes shop drawings for fabrication and erection of all work, parts lists, fabrication details, loading tables, anchor details, and manufacturer's installation instructions and details in accordance with the requirements of Section 01300.

With regard to 05100.2.6 – Slip Resistant Surfaces, below, evidence of compliance with the requirements stated there shall be furnished from the grating manufacturer to the Engineer at the time of delivery of the gratings to the Project site.

05100.1.4 DEFINITIONS

Not used.

05100.2 MATERIALS**05100.2.1 GENERAL GRATING REQUIREMENTS**

Grating shall be of such bar size and spacing that, as determined by the manufacturer, the grating will support a uniform loading of 180 pounds per square foot on the entire area of the grating, using an extreme fiber stress of not more than 10,000 pounds per square inch. The maximum deflection under this loading will not be more than 1/240 of the clear span of the grating. The spacing of the main grating bars shall not be more than 1-1/8 inches clear between bars. Crossbars shall be at right angles to the main bearing bars, and center to center spacing shall not exceed 4/4 inches. Ends of grating and cutouts shall be banded. Grating shall be of the thickness shown on Drawings or as required by these Specifications. All grating supplied to the project shall be by one manufacturer.

05100.2.2 STEEL BAR GRATING

Shall be machine-welded, galvanized carbon steel bearing bars and cross bars. Bearing bars for steel grating shall be not less than 1-1/2 inches in depth, unless directed otherwise by the Engineer. Spacing of bearing bars and cross bars shall not be less than those required in 05100.1.1.1 above. Span length of the bearing bars shall be in accordance with the information shown on the Drawings. The grating shall in all cases, meet the load and deflection requirements of 05100.1.1.1.

05100.2.3 ALUMINUM GRATING

Shall be I-bar or rectangular bar type grating with bearing bars and cross bars locked together by a swaging process. Bearing bars for aluminum grating shall be not less than 2 inches in depth, unless shown otherwise on the Drawings, or unless directed otherwise by the Engineer. Spacing of bearing bars and crossbars shall be as required in 05100.1.1.1 above. Span length of the

bearing bars shall be in accordance with the information shown on the Drawings. The grating shall in all cases, meet the load and deflection requirements of 05100.1.1.1.

Aluminum grating shall be supported on aluminum shelf angles cast in the concrete as indicated on the Drawings. Gratings, shelf angles, anchors, etc. shall be of 6061-T6 or 6063-T6 aluminum alloy, except that cross bars may be of 6063-T5 aluminum alloy. All surfaces of shelf angles, anchors, etc. to be in contact with concrete shall be coated as specified under Division 9.

05100.2.4 FIBERGLASS GRATING

Shall be constructed of fiberglass strands set in thermoset plastic in a one-piece mold. Glass content shall not exceed more than 35 per-cent by weight. The resin shall be an opaque, fire retardant polyester or vinyl material with a UL classification. The color and mesh pattern shall be indicated on the Drawings. Bearing bars for fiberglass grating shall be not less than 3 inches in depth, unless directed otherwise by the Engineer. Spacing of bearing bars and cross bars shall be the manufacturer's standards, but load capacity and deflection shall meet all requirements of 05100.1.1.1 above. Span length of the bearing bars shall be in accordance with the information shown on the Drawings.

05100.2.5 FLOOR PLATE

Shall be a commercial grade of hot-dipped, galvanized carbon steel or aluminum plating with a raised pattern of surface projections to resist slippage of foot traffic. The size, thickness, span length and pattern configuration shall be as shown on the Drawings but, in no case shall the thickness be less than 1/4-inch.

05100.2.6 CAST IRON GRATING

Shall be cast gray iron meeting the requirements of ASTM 48-93, Class 35B of the type and configuration shown on the Drawings. Castings shall be of uniform quality and free from blow holes, smooth and cleaned by shot-blasting. The size, minimum weight, spacing and span length of the grating sections shall be in accordance with the requirements indicated on the Drawings. Gratings located in areas subject to vehicular traffic shall be capable of sustaining standard highway H-20 loads. Bearing surfaces between grating and supporting cast iron frames shall be machined to allow full contact between the grating and fence.

05100.2.7 SLIP RESISTANT SURFACES

When slip resistant surfaces are required by the Drawings or these Specifications, such surfaces shall conform to all applicable OSHA standards and to USDA/FDA requirements for the food and drug industry, when applicable.

05100.3 CONSTRUCTION REQUIREMENTS

05100.3.1 PREPARATION

The Contractor shall carefully prepare the supporting structure to provide a neat fit and unobstructed walking surface in accordance with the Drawings. A clearance of 1/4-inch shall be provided for grating sections to provide easy removal and minimal movement when tread on. Openings for piping or other obtrusions shall be reinforced to support bearing components of the grating.

05100.3.2 Gratings shall be furnished and installed with appropriate clips and/or fasteners as recommended by the grating manufacturer. Supporting frames for grating shall be fabricated from materials which will not contribute to the corrosion or deterioration of the grating and which will provide

uniform support to the grating sections. Grating frames shall be designed to be removable and/or replaceable unless shown otherwise on the Drawings.

05100.3.3 Grating located in areas subject to foot and vehicular traffic shall have opening spaces sufficiently small as to not allow entrapment of bicycle or wheelchair wheels.

05100.3.4 Support for grating sections shall be constructed in full compliance with the recommendations of the grating manufacturer. Openings for piping or other obtrusions shall be properly reinforced to provide support of the bearing components of the grating section.

Except as otherwise specified or shown on the plans, grating shall be supported on shelf angles cast in the concrete as indicated on the plans. All surfaces of shelf angles, rebates, anchors, etc. to be in contact with concrete shall be coated as specified under Division 9.

05100.3.5 The clear opening space for grating section shall provide sufficient space for easy removal of sections; however, it shall not be oversized to allow excessive movement of the sections. Unless otherwise indicated, this clearance space shall be ¼-inch between grating sections and supporting frames. The top surfaces of grating sections adjacent to each other shall be in the same plane.

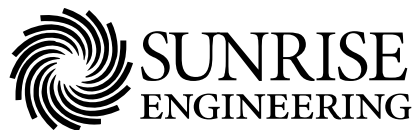
05100.4 METHOD OF MEASUREMENT

Separate measurement of the floor will not be made when the material is installed as a component of a building or structure listed in the Bid Schedule.

05100.5 BASIS OF PAYMENT

Separate payment will not be made for floor grating included in the measurement of a building or structure in which it is installed.

DIVISION 8
DOORS AND WINDOWS



08110.1 DESCRIPTION

This section of the specifications covers the furnishing and installing of all doors, transoms, center panels, windows, and associated finished hardware. In general, details, door and window types and sizes are indicated on the Plans.

08110.1.1 RELATED WORK

Not used.

08110.1.2 SUBMITTALS

08110.1.2.1 SHOP DRAWINGS - Shop drawings shall be submitted to the Engineer for his approval. Shop drawings shall show all details of doors, frames, windows, and accessory items, including all details or proper anchorage to the adjacent wall construction in each case.

08110.1.2.2 DESCRIPTIVE LITERATURE - Descriptive literature which identifies the manufacturer, model numbers, materials of fabrication and sizes shall be provided in accordance with Section 01300 of these Specifications.

08110.1.2.3 MANUFACTURER'S LITERATURE - Any manufacturer's literature provided for maintaining and operating their doors and hardware shall be furnished to the Owner prior to the time of final acceptance for payment.

08110.1.2.4 STAINED SAMPLES – See 08110.2.2.4 below.

08110.1.3 DEFINITIONS

Not used.

08110.2 MATERIALS**08110.2.1 STEEL DOORS**

All steel doors indicated in the Door Schedule and their pressed steel frames shall be hollow steel doors as detailed on the Plans and specified herein.

Doors and frames shall be made of prime quality, cold-rolled, pickle annealed, stretcher leveled steel, free from scale, pitting, and surface defects.

Hollow metal doors shall be 1-3/4 inches thick flush type, constructed of 2 sheets of not less than 16-gauge steel sheets formed and welded for flush pan assembly, with internal 20-gauge vertical reinforcing channels spaced not over 8 inches on centers the full height of the door. Reinforcing channels shall be uniformly spot welded to mated pans. Continuous 18-gauge stiffener channels shall be welded to faceplates top and bottom of all doors. Filler channels shall be provided at the top of exterior doors and also at the bottom of doors with thresholds to provide flush closure. All interior void spaces shall be completely filled with not less than 3-pound density rock wool or polyurethane. There shall be no visible joints on the face of the doors.

Concealed sheet or bar steel reinforcing shall be provided for mortise type hardware. Reinforcing shall be not less than the following: 9-gauge for butts; 12-gauge for locksets; and 14-gauge for surface applied hardware. Reinforcing shall be drilled and tapped to template requirements. Concealed reinforcing shall be provided for closers.

08110.2.1.1 OPENINGS

Where indicated in the Door Schedules on the Plans, doors shall be provided with glazed openings. Moldings shall be integral with and welded into the door providing 2 recessed rebates at all openings. The top and bottom interior glazing stop shall be removable and shall be flush with face sheets of door. Doors with glazed openings shall be Overly door type, or approved equal.

08110.2.1.2 ASTRAGALS

Astragals shall be provided on the active leaf of all exterior double doors and shall be a 1-3/4 inches wide, 12-gauge steel strip extended the full height of the door.

08110.2.1.3 FRAMES

Frames for hollow metal doors shall be pressed steel as indicated on the Plans. Pressed steel frames shall be constructed of not less than 16-gauge steel and shall be of the shape indicated on the plans and as required to fit the various wall construction. Frames shall be of welded unit construction assembled and welded in the shop. Welding shall be to the hairline joint with all exposed beads ground smooth. Jamb rebates shall be provided for three gray rubber door silencers. Concealed forcing of the frames for mortise hardware shall be not less than the following: 3/16-inch for butts; 12-gauge for lock strike; 14-gauge for surface applied items; and 18-gauge plaster guards over mortised hardware reinforcement. Frames shall be mortised drilled, and tapped to template requirements. Lock reinforcing units shall be supplied by finish hardware supplier. Frames in concrete shall be held in place by grout poured in keyways provided at all heads and jambs. Anchors for doorframes in masonry shall be Overly No. 111, or approved equal.

After shop assembly, doors and frames shall be cleaned thoroughly, ground smooth, and all seams along the edges of the door shall be filled flush with mineral filler. All doors and frames shall be bonderized and given one shop coat of rust inhibitive primer.

Gray rubber mutes shall not be installed until after painting, and then installation shall be deferred until as late in the job as possible, to avoid loss or damage. Before installation of the rubber mutes, the space behind the holes which are to receive the mutes shall be thoroughly cleared of any mortar or other obstructions which might prevent the mutes snap-locking into place.

08110.2.2 WOOD WALK DOORS

08110.2.2.1 DOORS - Wood doors shall be furnished and installed where shown on the Plans and as specified herein. Doors shall be flush veneered, prefinished, with a clear thermoplastic film 3 mils thick, edges sealed, and individually carton packed. Doors shall be guaranteed by the manufacturer according to the N.W.M.S. Standard Door Guarantee.

08110.2.2.2 DOORFRAMES - Doorframes, except fire door, shall be extruded anodized aluminum as indicated on the Plans. Door frames and accessories shall be color anodized as indicated on the Drawings or required in these Specifications.

08110.2.2.3 FIRE-RATED WOOD DOOR - Door shall be 1-3/4-inch, "Label B", one-hour mineral core fire door as manufactured by Weyerhaeuser Company; Paine Lumber Co., Inc.; or approved equal. Face veneer shall be Rotary Select White Birch and the door shall bear the "Label B" Underwriter's Laboratory designation. The door shall be installed in a UL approved frame.

08110.2.2.4 **SOLID CORE DOORS** - Solid core doors shall be solid particleboard core as manufactured by Weyerhaeuser Company; Paine Lumber Company, Inc.; or approved equal. Face veneers and edges shall be stained. Stained samples shall be submitted to the Engineer for approval prior to staining of the actual door.

08110.2.2.5 **HOLLOW CORE DOORS** - Door face veneers and edges shall be Rotary White Birch, and shall be Paine Lumber Co. "Rezo Type", or approved equal.

08110.2.3 **TRANSOMS AND CENTER REMOVABLE PANELS**

Transoms shall be either glass or steel panel as indicated in the Door Schedule on the Plans. All transoms and center panels shall be easily removable with clips as indicated on the Plans. All center panels shall match the door in which the center panel is placed, in thickness, material, and finish unless otherwise noted in these Specifications or on the Plans.

Glass transoms shall have 1/4-inch tinted tempered plate glass and shall be shop glazed in 6063T5 extruded aluminum sashes.

Steel transoms shall match the door over which the transom is placed in thickness, material and finish. Each transom shall have a neoprene gasket between the steel back and the transom. The clip shall tighten the transom against the neoprene gasket.

08110.2.4 **DOOR HARDWARE**

Shall be as follows:

08110.2.4.1 **PANIC BAR LATCH** - All exterior doors shall be equipped with panic bar latching devices, Rim 80 Series by Sargent and Company, Apex 2000 Series by Precision or approved equal.

08110.2.4.2 **DOOR CLOSURES** - Doors shall be equipped with Series 351 closures as manufactured by Sargent and Company, QDC 100 Series by Stanley, or approved equal. All closures shall have hold-open features, and shall be ADA compliant.

08110.2.4.3 **KNOB LATCH SET** – Shall be as follows:

- Latch sets for exterior walk doors shall meet Fed. Spec. FFH-106a-161A. They shall be stainless steel unless specified otherwise on the door schedule. One latch set is required for each single door and one for the active-leaf on double doors on all exterior walk doors. Latch sets shall be locked/unlocked by key from the outside knob and pushbutton locked from the inside. Sargent 11 Line by Sargent Company, 9K Series by BEST, or approved equal.
- Latch sets for interior doors shall meet Fed. Spec. FFH-106a-161N. They shall have no locks. Knobs shall be Tulip type rasp.

08110.2.4.4 **DEADLOCKING LATCH:** Dead lock latches shall have a dead lock, double cylinder B252PD as manufactured by Schlage Locks, T Series by Stanley, or approved equal where shown on the door schedule.

08110.2.4.5 **KEYING:** Locks shall be keyed in conjunction with the existing system. Keying shall be submitted and is subject to Engineer's approval.

08110.2.5 **LOCKS**

Shall be Series 11 Line by Sargent, 9K Series by BEST, or approved equal, with L stainless steel levers. Five keys shall be provided for each lock set.

08110.2.6 HINGES

Shall be full mortise, five knuckle, with non-removable hinge pins. The hinges shall be 5 Knuckle Ball Bearing Hinges by Stanley, or approved equal. Each door shall be fitted with three hinges.

08110.2.7 THRESHOLDS

Shall be extruded aluminum, No. 171A, by Pemko, or approved equal.

08110.2.8 DOOR GASKETING

Shall be vinyl bubble, held in place with aluminum molding around the perimeter of the door.

08110.2.9 DOOR BOTTON PROTECTION

All Doors shall be provided with an aluminum molding with a neoprene gasket, No. 315 AN, by Pemko or approved equal.

08110.3 CONSTRUCTION REQUIREMENTS**08110.3.1 MANUFACTURE AND SHIPPING**

All doors and doorframes shall be fabricated in a workmanlike manner. Hardware shall be installed by the door manufacturer. Hardware shall be installed so that the doors operate smoothly and with no binding

Doors shall be checked to assure that no damage has occurred during shipment to the Work site.

08110.3.2 INSTALLATION

08110.3.2.1 DOORS AND FRAMES - All doors and doorframes shall be installed in a workmanlike manner. All doors and frames shall be adjusted so that operation will be smooth, free, easy and with no binding in the hardware between doors and frames. Doors shall be set plumb, square and level at their proper elevation and location. All hardware shall be adjusted to operate smoothly, freely and properly. Door holders shall be installed on the outside of doors such that they will not cross the threshold when the door is opened.

Doors and frames shall be reinforced for hinges, locksets, strikes, flush bolts, etc., as required. Doorknobs are to be 40 inches above the floor to the centerline of the knob.

Wood doors shall be installed in accordance with the National Woodworkers Manufacturing Standards. After fitting at job site, all four edges shall receive two coats of clear compatible lacquer.

08110.3.2.2 STEEL TO ALUMINUM CONTACT - Wherever there is a steel to aluminum contact, the two metals shall be separated by butadyne tape or equal.

08110.3.2.3 GASKETING - Gasketing shall be installed in accordance with the manufacturer's recommendations. Installation of gasketing should be delayed until painting of the door and frame has been completed.

08110.3.2.4 **PAINTING** - Painting of the doors and frames shall be in accordance with the requirements of Section 09910 of these Specifications. Care shall be taken to assure door hardware is not painted.

08110.4 METHOD OF MEASUREMENT

No separate measurement will be made for doors and frames.

08110.5 BASIS OF PAYMENT

Payment for doors and frames shall be included in the contract unit price for the building on which the doors are installed and accepted.

08122.1 DESCRIPTION

The Contractor shall furnish and install embedded access hatches and associated fittings in designated structures in accordance with the Drawings and these Specifications.

08122.1.1 RELATED WORK

Section 03300 – Concrete Structures and Slabwork

08122.1.2 SUBMITTALS

08122.1.2.1 DESCRIPTIVE LITERATURE - Descriptive literature which identifies the manufacturer, model number, size and materials of fabrication for all equipment and materials furnished under this section shall be provided by the Drawings in accordance with Section 01300 of these Specifications.

08122.1.2.2 CERTIFICATION OF COMPLIANCE - Certification of compliance with the standards and Specifications contained herein shall be obtained from the manufacturer and provided by the Contractor at the time of delivery of these materials to the project site.

08122.1.3 DEFINITIONS

Not used

08122.2 MATERIALS**08122.2.1 QUALITY CONTROL**

This specification is not intended to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance. The Owner reserves the right to reject substitutions if in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

08122.2.2 HATCH

The embedded access hatch shall be as manufactured by the Bilco Company, or approved equal. The model number or type shall be shown on the Drawings, but as a minimum shall be equal to a Type K or Type KD, as applicable. Frame shall be ¼” extruded aluminum with built-in neoprene cushion and with strap anchors bolted to exterior. Door leaf shall be ¼” aluminum diamond plate reinforced with aluminum stiffeners as required. Cast steel hinges shall be bolted to underside and pivot on torsion bars that counterbalance the door for easy operation. The door shall open to 90 degrees and lock automatically in that position. A vinyl grip handle shall be provided to release the cover for closing. Doors shall be built to withstand a live load of 150 pounds per square foot, and equipped with a snap lock and removable handle. Aluminum shall be mill finish, with bituminous coating to be applied to exterior of frame by manufacturer.

08122.2.3 HARDWARE

Hardware shall be zinc plated and chromate sealed. Installation shall be in accordance with manufacturer’s instructions. Manufacturer shall guarantee against defects in material or workmanship for a period of five years.

08122.3 CONSTRUCTION REQUIREMENTS

The Contractor shall install all equipment and components under this section in accordance with the manufacturer's installation instructions, the Drawings and these Specifications. Where instructions are unavailable or unnecessary, the Contractor shall at all times use good workmanship practices, applicable building codes, and regulations. The Contractor shall supply and install all miscellaneous fittings required to provide a complete operating system or component, as applicable.

08122.4 METHOD OF MEASUREMENT**08122.4.1 NO MEASUREMENT**

Unless a separate bid item for furnishing and installing the work outlined in this Section is provided in the Bid Schedule, this work shall not be measured for separate payment, but shall be considered incidental to other items in the Bid Schedule.

08122.4.2 SEPARATE MEASUREMENT

Where items installed under this section are listed separately in the Bid Schedule, the items shall be measured by counting the number of units installed and accepted.

08122.5 BASIS OF PAYMENT

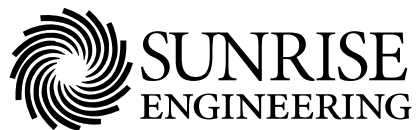
Complete compensation for the accepted work outlined in this Section shall be included in other bid items when no separate bid item is provided in the Bid Schedule for this work.

When a separate bid item is provided in the Bid Schedule, complete compensation for this accepted work shall be included in the contract unit price on the Bid Schedule.

PAY ITEM	UNIT
Embedded Access Hatch (<i>Type</i>)	Each

DIVISION 9

FINISHES



09210.1 DESCRIPTION

It shall be the responsibility of the Contractor to coordinate with the Owner and/or the Engineer on the color of paint to be used on the referenced materials.

09210.2 MATERIALS**09210.2.1 CONCRETE AND MASONRY**

- A. The project building(s) shall be constructed as shown on the plans. Concrete work shall conform to the requirements of Division 3, and shall be Class A concrete. All work shall be neat and workmanlike. The surface of the entire structure, both interior and exterior, shall have any irregularities ground smooth. After being smoothed, the exterior surface of the structure shall be brushed with a mixture of 1/3 water, 1/3 cement, and 1/3 sand. The thickness of the brushed on mixture shall not exceed 1/8 inch.
- B. Exposed Concrete or masonry interior walls shall be sealed with a high quality concrete sealer and painted with one coat of white, high gloss enamel paint or other color as may be specified.
- C. Unless a different color is specified, the interior floor of the building shall be sealed with a gray industrial cement floor sealer.

09210.2.2 P-TRAPS

Drain piping shall be drain waste and vent (DWV) schedule 40 PVC pipe and fittings sized to fit the floor drain in accordance with the Drawings.

09210.2.3 OTHER SURFACES

- A. All plywood and other wood surfaces shall be painted with two coats of wood seal primer and one coat of white, high gloss enamel paint unless other colors are specified.
- B. All doors shall be painted with two coats of high gloss epoxy paint.
- C. All exposed pipe shall be painted with two coats of high gloss epoxy paint. Where required, the paint shall be color coded to indicate the nature of the material being transported in the pipe.
- D. All factory painted items should be approved by the Owner prior to delivery to coordinate color combinations.

09210.3 METHOD OF MEASUREMENT

09210.3.1 This work shall not be measured for separate payment, but shall be considered incidental to other items in the Bid Schedule.

09210.4 BASIS OF PAYMENT

09210.4.1 Complete compensation for the accepted work outlined in this Section shall be included in other bid items.

09910.1 DESCRIPTION

The Contractor shall furnish all labor, materials and equipment necessary to paint all designated components of buildings, piping and equipment in accordance with these Specifications.

09910.1.1 RELATED WORK

Not used.

09910.1.2 SUBMITTALS

09910.1.2.1 DESCRIPTIVE LITERATURE - Descriptive literature identifying manufacturer, type, content, application recommendations, and color samples, shall be provided in accordance with Section 01300 of these Specifications.

09910.1.2.2 DATA FOR PAINT APPROVAL - Complete data on each type and kind of paint and primer shall be submitted to the Engineer for approval. Approval shall be received from the Engineer before the paint is delivered to the jobsite. This procedure must be followed whether or not the paint that the Contractor proposes to use is named in the Specifications. Approval data shall show where and for what uses each paint product is proposed. Information submitted on each proposed type and kind of paint shall include data to show that the paint meets the detailed requirements of these Specifications.

09910.1.2.3 SAMPLES - The Contractor shall prepare and submit sample colors for all items which require color selection by the Engineer. No color selection will be made until all samples of all paints have been submitted. After all samples of all paints have been submitted, the Engineer will prepare a color scheme using the submitted colors. Colors will not necessarily be standard colors with all suppliers. The manufacturer shall mix colors, to secure the desired color when it is not one of his standard colors.

09910.1.2.4 SAND BLAST PANELS - The Contractor, at the beginning of the Project, shall furnish one square foot steel panels sandblasted in accordance with the sandblasting specifications and coated with non-yellowing shellac or clear non-yellowing plastic coating. Panels shall be used as the standards for preparation of steel surfaces for the duration of the project.

09910.1.2.5 PAINT REMNANT - At the end of the project, the Contractor shall turn over to the Engineer a gallon can of each type and color of paint, primer, thinner, or other coating used in the field painting. If the manufacturer packages the material concerned in gallon cans, then it shall be delivered in unopened labeled cans as it comes from the factory. If the manufacturer does not package the material in gallon cans, and in the case of special colors, the materials shall be delivered in new gallon containers, properly closed with typed labels indicating brand, type, color, etc. The manufacturers' literature describing the materials and giving directions for their use shall be furnished in three bound copies. A typewritten inventory list shall be furnished at the time of delivery.

09910.1.3 DEFINITIONS

Submerged Surfaces - In general, items shall be treated as submerged if they are to be at any time under water or are in structures that normally contain water. Unless specified otherwise, anything below the tops of the walls of such structures shall be considered as submerged.

09910.2 MATERIALS**09910.2.1 QUALITY CONTROL**

This Specification is not intended to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance. The Owner reserves the right to reject substitutions if in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

09910.2.2 **COLOR**

The Engineer will make color selection from color samples provided by the Contractor.

09910.2.3 **PAINT SELECTION**

All paint and coating systems shall include high quality materials, resistant to temperatures up to 130°F, and sunlight exposure. Paints selected shall meet the manufacturer’s recommendations and suitability standards for the specific application where it will be used.

09910.2.3.1 **MINIMUM REQUIREMENTS** - Minimum requirements for paint materials and their application shall be as shown in the tables below:

EXTERIOR PAINT APPLICATION TABLE

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Wood Siding, Trim, Doors	1	A-100 Exterior Alkyd Wood Primer	2.3
	2	A-100 Exterior Latex Flat House & Trim by Sherwin Williams - OR -	1.3
	1	SUPRIME 8 Exterior	1.3
	2	Pro-Hide Plus Latex Satin House by Pratt & Lambert- OR -	1.3
	1	System 2H-4 Alkyd by Tnemec	2.5
	2	Tnemec Series 10-99W Undercoater 2H-Color Hi-Build Tnemec Gloss	2.5
Porous Masonry (Block)	2	Series 156 Modified Epoxy Sand Texture Finish by Tnemec Series 156, 25 BR	4-8
Concrete Walls, Above Grade	1	Loxon Ext. Masonry Acrylic Primer	3.1
	2	A-100 Exterior Latex Satin House & Trim by Sherwin Williams -OR -	1.3
	2	Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR –	1.3
	2	Series 1029 Acrylic Latex Low Sheen by Tnemec	2.5
Metal (Aluminum)	2	A-100 Exterior Latex Satin House & Trim by Sherwin Williams - OR -	1.3
Metal (Aluminum) Continued	1	SUPRIME 3 Latex Metal Primer	1.3
	2	Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR –	1.3
	1	DEFLEX 4020 Primer	3
	1	DEFLEX 4206 S/G Waterborne Acrylic Enamel by DeVoe	1.5
Metal, New Steel, (Mild Service)	1	Kem Kromik Universal Metal Primer	2.5
	2	Direct to Metal Enamel by Sherwin	3.0

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
	1	Williams - OR - SUPRIME 3 Latex Metal Primer	1.3
	2	Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR –	1.3
	1	Devguard 4160 Primer followed by	2
	1	Devguard 4308 Alkyd Enamel or	2
	2	DEFLEX 4218 DTM Enamel by DeVoe	2
Metal, New Steel, (Severe Service)	1	Series 27 WB Typoxy by Tnemec	4
	1	73-Color Endura-Shield	2
Metal, Galvanized Steel, (Mild Service)	1	Galvite HS	2.0
	2	A-100 Exterior Latex Satin House & Trim by Sherwin Williams -OR -	1.3
	1	SUPRIME 2 Latex Metal Primer	1.3
	2	Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR –	1.3
	1	Devguard 4020 Primer	3
	2	DEFLEX 4206 S/G Waterborne Acrylic Enamel by DeVoe	1.5
Metal, Galvanized Steel, (Severe Service)	1	Series 27 WB Typoxy by Tnemec	4
	1	Series 10 Primer by Tnemec	2
PVC Pipe		System 66-23 Epoxy Polyamide by Tnemec	
	1	66-Color Hi-Build Epoxoline	4

INTERIOR PAINT APPLICATION TABLE

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Woodwork	1	ProMar 200 Alkyd Enamel Undercoater	1.9
	2	ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams-OR	1.7
	1	SUPRIME 11 Int Alkyd Wood Primer	1.5
	2	Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	1.5
Woodwork Continued		System 2H-4 Alkyd by Tnemec	
	1	Series 10-99W Tnemec Primers	2.5
	2	2H-Color Hi-Build Tnemec Gloss	2
Drywall	1	ProMar 200 Latex Wall Primer	2.5
	2	ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR -	1.8
	1	SUPRIME 1 100% Acrylic MP Primer	1.1
	2	Pro-Hyde Plus Latex Satin by Pratt & Lambert – OR –	1.5
		System 6-1 Acrylic Latex Low Sheen by Tnemec	
	2	Series 1029 Enduratone	2

PAINTING

**SECTION
09910**

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Metal (Aluminum)	1	SUPRIME 9 Int/Ext Alkyd Metal Primer	1.1
	2	Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	1.5
	1	DEFLEX 4020 Primer	3
	1	DEFLEX 4206 Semi-Gloss Waterborne Acrylic Enamel	1.5
Metal, New Steel, (Mild Service)	1	Kem Kromik Universal Metal Primer	2.5
	2	ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR -	1.7
	1	SUPRIME 9 Int/Ext Alkyd Metal Primer	1.1
	2	Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	1.5
	1	Devguard 4160 Primer followed by	2
	1	Devguard 4308 Alkyd Enamel or	2.5
Metal, New Steel, (Severe Service)	1	System 66-2 Epoxy Polyamide by Tnemec	3.5
	1	66-1211 Epoxoline Primer 66-Color Hi-Build Epoxoline	4
Metal, Galvanized Steel, (Mild Service)	1	Galvite Paint	2.0
	2	ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR -	1.8
	1	SUPRIME 9 Int/Ext Alkyd Metal Primer	1.1
	2	Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	1.5
	1	Devguard 4020 Primer	3
Metal, Galvanized Steel, (Severe Service)	1	System 66-2 Epoxy Polyamide by Tnemec	3.5
	1	66-1211 Epoxoline Primer 66-Color Hi-Build Epoxoline	4
Ductile Iron (DI) Pipe and fittings	1	SUPRIME 9 Int/Ext Alkyd Metal Primer	1.1
	2	Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	1.5
	1	Devguard 4160 Primer followed by	2
	1	Devguard 4308 Alkyd Enamel or	2.5
	2	DEFLEX 4218 DTM Enamel by DeVoe	2
PVC Pipe (Mild Service, Interior Only)	2	System 6-1 Acrylic Latex Low Sheen by Tnemec Series 1029 Enduratone	2
PVC Pipe (Severe Service)	1	System 66-23 Epoxy Polyamide by Tnemec 66-Color Hi-Build Epoxoline	4
Concrete Walls and Ceilings (Mild Service)	1	ProMar 200 Latex Wall Primer	1.1
	2	ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR -	1.3
	1	SUPRIME 4 Latex Wall Primer	1.2

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
	2	Pro-Hyde Plus Latex Satin by Pratt & Lambert	1.5
Concrete Walls and Ceilings (Severe Service)	2	System 66-4 Epoxy Polyamide by Tnemec Series 27 WB Typoxy by Tnemec	4
Porous Masonry Walls (Mild Service)	1	Pre-Prime 167 by Devoe	1.5
	2	ProMar 200 Latex Wall Primer	1.1
		ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR -	1.3
	1	SUPRIME 4 Latex Wall Primer	1.2
	2	Pro-Hyde Plus Latex Satin by Pratt & Lambert	1.5
Porous Masonry Walls (Severe Service)	1	System 66-15 Epoxy Polyamide by Tnemec	75-100
	2	54-660 Masonry Filler Series 27 WB Typoxy by Tnemec	4
Concrete Floors (Mild Service)	1	Pre-Prime 167 by Devoe	1.5
	1	Concrete and Terrazzo Sealer (ANCO Cure and Hard by Intermountain Concrete Specialties.	None
	2	Industrial Enamel by Sherwin Williams - OR -	2
	2	With STAND Alkyd Floor Enamel by Pratt & Lambert – OR –	1
	2	Devguard 4328 Alkyd Enamel by DeVoe	2
Concrete Floors (Severe or Mild Service)	2	System 67-1 Epoxy Polyamide Semi-Gloss by Tnemec 67-Color Tnemec Tread	2.5

*Brand names of materials have been used to indicate the types and quantities of materials required. Approved equals will be accepted.

09910.2.3.2 PAINT FOR WASTEWATER SYSTEMS - All paint for concrete and metal surfaces in wastewater systems shall be especially adapted for such use.

- Fume Resistance. All paint for final coats shall be fume resistant, compounded with pigments suitable for exposure to sewage gases, especially to hydrogen sulfide and to carbon dioxide. Pigments shall be materials, which do not tend to darken, discolor, or fade due to the action of sewage gases. If a paint manufacturer proposes use of paint which is not designated “fume resistant” in its literature, it shall furnish full information concerning the pigments used in this paint.
- Lead Paint. No lead paints shall be used.

09910.2.3.3 PAINT FOR POTABLE WATER SYSTEMS - All paint systems to be used in potable water service shall meet NSF requirements. See also Subsection 09910.2.3.5 below.

09910.2.3.4 PAINT FOR SUBMERGED SURFACES

- Coal Tar Epoxy. Coal tar epoxy shall meet and conform with Government Specification Mil P-23236 with further qualification that the coal tar epoxy manufacturer and product must be listed on the current U.S. Navy Qualified Products List. Coal tar epoxy shall be subject to the Engineer's approval.
- Alternate Systems. Alternate coating systems for submerged service, such as Epoxy Polyamide Epoxoline by Tnemec, Epoxy Bar Rust 233H, by DeVoe, or equal, may be required for some applications, or may be approved in lieu of coal tar by the Engineer, upon request. Some colors of Epoxy Polyamide Epoxoline, or equal may be acceptable for use in potable water systems, however the manufacturer must be consulted for verification of acceptability prior to use in potable water applications.

09910.2.3.5 HIGH TEMPERATURE SURFACE TO 400°F - Paint for high temperature surfaces shall be DeVoe Hi-Heat Aluminum HT-4, Glidden 592 Metallite Aluminum, or Sherwin-Williams Silver-Brite Heat resisting aluminum paint B59 S1, or approved equal.

09910.2.4 CLEANING MATERIALS

Cleaning materials shall be best quality solvents, chemicals or detergents, which are commercially prepared for preparing painted surfaces and delivered to the site in sealed containers bearing an identifying label and the manufacturer's name.

09910.3 APPLICATION REQUIREMENTS

ALL paint and coating systems shall be applied in strict accordance with the manufacturer's published instructions for use.

09910.3.1 SURFACE PREPARATION

09910.3.1.1 CLEANING - All surfaces to be painted shall be clean and dry except that in some cases the paint manufacturer's directions may require wetting the surface before painting. Grease and oil shall be removed by wiping with mineral spirits or naphtha per Specification SP-1. Rust, scale, welding slag, and spatter shall be removed and the surface prepared by hand tool cleaning, power tool cleaning, or blast cleaning in accordance with the appropriate Specification SP-2 through SP-10.

09910.3.1.2 METAL SURFACES - Except as otherwise provided, all preparation of metal surfaces shall be in accordance with Specifications SP-1 through SP-10 of the Steel Structures Painting Council (SSPC). Sandblasting procedures shall be as follows:

- No surface, which is to be sandblasted, shall be given a coat of primer or paint in the shop or in the field before sandblasting.
- Unless otherwise specified, all iron or steel surfaces which are to be painted as submerged metal shall be dry sandblasted on the site in accordance with Specification SP-10, near white blast cleaning.
- Except as otherwise specified, all metal surfaces, which are to be painted as non-submerged metal, shall be commercial blast cleaned per Specification SP-6. This sandblasting shall be done not more than 12 hours ahead of the painting, subject to humidity and weather conditions between the time of sandblasting and painting operations. If any rusting of sandblasted surfaces occurs before painting, such rusting shall be removed by additional sandblasting.

- Threaded portions of valve and gate stems, machined surfaces intended for sliding contact, surfaces to be assembled against gaskets, surfaces of shafts for sprockets or to fit into bearings, machined surfaces of bronze trim on slide gates, and similar surfaces shall be masked off to protect them from the sandblasting of adjacent surfaces.
- Cadmium-plated or galvanized items shall not be sandblasted except that cadmium plated, zinc-plated, or sheradized fasteners used in assembly of equipment to be sandblasted shall be sandblasted in the same manner as the other metal.
- Surfaces which cannot be sandblasted, or cannot be sandblasted and then painted after the assembly of which they are a part has been completed and placed in final position, shall be sandblasted, or sandblasted and painted, before the items are put into final position. In some cases, while the painting could be done after the items concerned were in place, the limitation on time between sandblasting and painting may make it necessary to paint the surfaces before installation of those items.
- Sand or other media residue from sandblasting operations shall be thoroughly removed, using any method necessary and consistent with the requirements of the painting system, including vacuum cleaners or other means.

09910.3.1.3 GALVANIZED SURFACES - Galvanized surfaces which are to be painted shall first be treated with Koppers No. 40 Metal Conditioner; Amercoat No. 59 as manufactured by Amercoat Corporation, Brea, California; Galvaprep No. 5 as manufactured by Amchem Products, Fremont, California; or approved equal.

09910.3.1.4 CONCRETE SURFACES - Concrete and masonry surfaces shall be free of dust, mortar droppings and spatter, fins, loose concrete particles, form release materials, oil, grease, and other deleterious materials. If required by the coating manufacturer, such surfaces shall be etched as specified below or brush off blast cleaned per Specification SP-7.

Concrete surfaces specified to be acid etched shall be etched with a 15 to 20 percent solution of muriatic or sulfamic acid until the surface has the texture of fine sandpaper. The surface shall then be thoroughly scrubbed with clean water, rinsed, and allowed to dry.

09910.3.1.5 WOOD SURFACES - Wood shall be cleaned and dusted immediately prior to painting. Final dusting shall be accomplished using tack cloth. Shelves, drawers, benches, and associated woodwork shall be sanded before painting and lightly sanded between coats. Prior to application of each coat, the surfaces shall be again dusted with tack cloth to remove all dust.

09910.3.1.6 BITUMINOUS PAINTED SURFACES - Surfaces, which are to be painted with other than bituminous paint, and which have a bituminous coating (such as coal tar varnished pipe), shall be sealed with not less than 2 coats of Inertol Tar Stop; Sherwin-Williams Metalatex B42W100; Glidden Insulcap as manufactured by the Glidden Company; or approved equal. This seal coating shall be applied in sufficient quantity to permanently prevent bleeding of the bituminous coating.

09910.3.1.7 HIGH TEMPERATURE SURFACES - In general, high temperature paint shall be applied to exposed (un-insulated) steam line valves and traps, heat exchangers, and miscellaneous metal piping and equipment in piping and mechanical systems exposed to high temperatures. The Contractor shall paint these surfaces with two coats of high temperature paint as specified herein or as otherwise shown or directed. No painting shall be done on surfaces with a temperature in excess of 125 degrees F at the time of application. Immediately before application of the first coat of paint, the surface shall be sandblasted according to SSPC-SP-5 (Blast Cleaning to "white" metal). See also Subsection 09910.3.1.2 above.

- 09910.3.1.8 THINNING - No thinning of paint other than as directed by the manufacturer's published directions shall be done without the approval of the Engineer. No painting shall be done under conditions, which, in the opinion of the Engineer, will jeopardize the appearance of quality of the painting in any way.
- 09910.3.1.9 TINTING OF FIRST COAT - When two coats of the same material are specified, the first coat applied shall be tinted with aluminum powder, lampblack, or other suitable pigment to distinguish it from the top coat.
- 09910.3.1.10 BETWEEN-COATS TREATMENT - All painted surfaces shall be dusted between coats, and high gloss finish shall be lightly sanded and dusted between coats unless otherwise directed by the manufacturer.
- 09910.3.2 PAINT APPLICATION
- 09910.3.2.1 PAINTER QUALIFICATIONS - Contractor or subcontractor personnel applying the coating system shall have had past experience in application of the type or types of coatings and under similar conditions that it will be required to meet in this contract. The qualifications of personnel applying the coating system, whether Contractor or subcontractor shall be verified by the Contractor prior to allowing application to proceed. The Contractor shall not subcontract paint application to a subcontractor that is not qualified to apply the coating system.
- 09910.3.2.2 WEATHER CONDITONS - No painting shall be done under dusty conditions, during or immediately after a rain, during rainy weather, or when the temperature is less than 50°F.
- 09910.3.2.3 GENERAL REQUIREMENTS FOR APPLICATION OF PAINT – These requirements shall be as follows:
- All work shall be done in a workmanlike manner, leaving the finished surfaces free from drops, ridges, waves, holidays, laps, or brush marks.
 - Where possible, prime coats shall be applied by brush and well worked into the surface, unless directed otherwise by the paint manufacturer.
 - Other paints may be applied by brush, roller, trowel, or spray, unless manufacturer's recommendations or these Specifications require a particular method of application.
 - Primer and intermediate coats of paint shall be un-scarred and completely integral at the time of application of each succeeding coat.
 - Each coat shall be subject to the inspection and approval of the Engineer before the next succeeding coat is applied, and defective work of any kind shall be deemed sufficient cause for re-coating the entire surface involved.
 - Where spray application is used, each coat of paint shall be applied to a thickness equivalent to a brush coat application at a coverage rate not greater than that specified by the manufacturer for a brush coat application. All spray painting shall be done with airless type spray units.
 - The time interval between paint coats shall meet the recommendations of the paint manufacturer, and these Specifications. The Contractor shall not allow excessive time or exposure between coats, where such excessive time or exposure will impair the bond between the coats.

- The number of coats specified in these Specifications is the minimum to be applied. Suction spots between coats shall be touched up, and additional coats shall be provided if required to produce a finished surface with a solid, even color free from defects.
- The total thickness of the coating shall be as specified. Additional coats of paint shall be added if necessary to bring the total thickness up to not less than that specified. For control, the Contractor shall determine the dry film thickness of the coatings on metal surfaces with a correctly calibrated thickness meter. The Contractor also shall check for holidays with a low voltage holiday detector. The Engineer may use the Contractor's meter and detector for additional inspection and checking deemed necessary.
- Particular care shall be used to assure that the specified coverage is secured on the edges and corners of all surfaces. Additional brush coats shall be applied if necessary to ensure coverage of the edges and corners.
- Damaged paint or scratched painted surfaces shall be sanded smooth before repainting. Sanding and repainting shall be done to such a degree and in such a manner that all evidence of the scratches or damages is obscured.

09910.3.2.4 COAL TAR EPOXY – Application of coal tar epoxy shall be as follows:

- Where called for in the Painting Schedule, shown on the Drawings, or required in these Specifications, concrete and some other submerged surfaces shall be coated with not less than two coats of coal tar epoxy.
- Only components from new, previously unopened containers shall be used to mix coal tar epoxy coatings. Coal tar epoxy shall be mixed and applied in accordance with the manufacturer's recommendations. All coating components shall be mixed with power mixers. The time during pouring or stirring will not be allowed as mixing time. The minimum mixing time as recommended by the manufacturer shall be met. Only unit quantities shall be mixed.
- Coal tar epoxy shall be applied to a total dry film thickness of not less than 16 mils.
- Some metal surfaces may require sandblasting prior to application of the coating system. See Subsection 09910.3.1.2 above.
- In some cases it may also be necessary to apply coatings to parts or subassembly surfaces before they are actually installed at their final Project or system location. All support brackets, stem guides, pipe clips, fasteners, etc. that are bolted to concrete shall be painted on all sides.
- Application of coal tar epoxy shall be performed only at the job site unless specific approval is granted for offsite application. Offsite application will not be allowed unless by an applicator with acceptable proven and documented experience in the application of coal tar epoxy systems.
- Each succeeding coat shall be applied over the previous coat as soon as possible in accordance with the manufacturer's instructions, without causing sagging. Succeeding coats shall not be delayed longer than allowed by the manufacturer's instructions. In no case shall the application of subsequent coats be made after the previous coat has set or oxidized. All coats, and the full thickness on all parts, shall be applied before the previous coat has cured. The Contractor shall check the film thickness after application, and before the coating has cured, to ensure that sufficient coating thickness has been applied. If additional coating is necessary, it

shall be applied the same day. Checking and control of thickness at this stage shall be the Contractor’s obligation and responsibility and not the Engineer’s.

- If the surface coating has been applied for a longer period of time than the limits in the Table below, and if it is found that bituminous paint has not been applied to the specified thickness, the areas that are too thin shall be sandblasted to remove the surface film from the coating. These sandblasted areas shall then be washed and cleaned with the solvent recommended by the manufacturer and shall be re-coated within the time limits specified for coating over fresh bituminous paint. Washing or cleaning the surface of the paint with solvents or other solutions will not be a satisfactory substitute for the specified sandblasting if the painted surface is older than the time limits indicated in the table. This applies even if the paint manufacturer approves the solvent method as adequate for preparing the old surface.

TEMPERATURES AND COATING TIMES

Average Temperature	Maximum Time Between Coats
50 - 60° F	36 hours
60 - 70° F	24 hours
70 - 80° F	12 hours
80 - 120° F	4 hours

Coal tar epoxy shall not be applied when the ambient temperature is less than 50 degrees.

09910.3.2.5 EDGES AND CORNERS - The Contractor is hereby CAUTIONED that the edges and corners of members are difficult places upon which to build the required thickness of paint. The required thickness must be applied to all surfaces, including the corners and edges, by applying as many spray coats as necessary or by additional brush coats on the corners and edges, if necessary, in order to build up the required thickness.

09910.3.3 FINISH SCHEDULE

The Contractor shall finish all work as follows unless indicated otherwise on the Drawings or within these Specifications:

TABLE OF FINISH SCHEDULES

NO FINISH	FACTORY FINISH	SITE FINISH
Stainless Steel Surfaces	Heating Units	Interior Concrete Building
Polished Aluminum Surfaces	Electric Control Panel Cabinets	Floors and Walls
Chain Link or Stock Fencing	Cranes & Hoists	Interior Building Walls &
Name Plates	Gauges and Meters	Ceiling
Exterior Concrete	Instruments	All Interior and Exterior
Exterior Masonry Surfaces	Light Fixtures and Cover Plates	Exposed Piping Valves & Pipe
Exposed Plastic Pipe & Fittings	Electrical Wiring & Transformers	Supports
Warning Labels	Ventilating Fans	Exposed Electrical Conduit &
Operating Instructions	Dampers	Junction Boxes
Gratings	Air Conditioning Units	Entry Doors and Frames
Buried or Encased Pipe	Metal Soffit & Fascia Covering	Wood Moldings and Trim
	Roofing and Siding	Other Exterior Surfaces
	Roll-Up Overhead Doors	Indicated on drawings
	Motors, Pumps, Equipment	

09910.3.4 CLEANUP

Upon completion of painting, the Contractor shall remove all masking and protective covers and properly dispose of all rubbish, debris and unused paint materials. The Contractor shall remove and cleanup all paint overspray, drips, spatters and etc. from any and all surfaces where it does not belong.

09910.4 METHOD OF MEASUREMENT**09910.4.1 NO MEASUREMENT**

Separate measurement for Painting will not be made when painting is included as part of an item, building or structure listed in the Bid Schedule.

09910.4.2 SEPARATE MEASUREMENT

Separate measurement for Painting will be made as a Lump Sum when painting is listed as a separate item in the Bid Schedule.

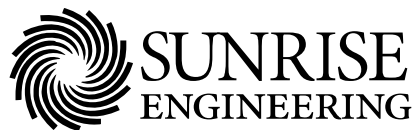
09910.5 BASIS OF PAYMENT

When Painting is included as part of the measurement of another item, structure or building listed in the Bid Schedule, separate payment will not be made.

When Painting is required for a specific item, the accepted quantity will be paid for at the contract unit price for:

PAY ITEM	UNIT
<i>Paint (Item Description)</i>	Lump Sum

DIVISION 10
BUILDING SPECIALTIES



10125.1 DESCRIPTION

Includes furnishing and installing electrically operated unit space heaters and their controls in designated buildings and equipment enclosures in accordance with the Drawings and these Specifications.

10125.1.1 RELATED WORK

Section 10150 - Ventilation Equipment
Section 16010 - General Electrical Requirements

10125.1.2 SUBMITTALS

The Contractor shall provide complete information, which includes cutaway drawings, dimensions, parts lists, power requirements, heating capacity and manufacturer's installation instructions in accordance with the requirements of Section 01300.

10125.1.3 DEFINITIONS

Not used.

10125.2 MATERIALS**10125.2.1 FORCED AIR HEATER**

Shall be new, with an enclosed motor; heating element and fan; wall or ceiling mounted; and fabricated from heavy gauge metals which are moisture and corrosion resistant. Heaters shall comply with the size and performance requirements indicated on the Drawings. Heaters shall be equipped with metal sheathed electric heating units wired to built-in line voltage automatic reset thermal overload protection. Heaters shall operate on the specified single or three-phase power supply at the specified standard voltage between 110 and 480 volts.

10125.2.2 RADIANT HEATERS

Shall be new heavy-duty commercial baseboard heater units with 16-gauge (min.) steel front covers coated for corrosion resistance and comply with the requirements for size and performance indicated on the Drawings. The heating unit shall be fabricated with copper or aluminum heat transfer fins bonded so that no vibration or observable noise from operation will result. Heaters shall operate on the specified single or three-phase power supply at the specified standard voltage between 110 and 480 volts.

10125.2.3 CONTROL OF FORCED AIR AND RADIANT HEATERS

Shall be provided thermostatically with the thermostat located on the heater or wall mounted in an efficient location that can be easily operated in the building. Thermostats shall be low voltage, mercury types.

10125.2.4 HEATER UNITS

All heater units shall be UL listed and shall be manufactured in compliance with NEC and OSHA standards.

10125.3 CONSTRUCTION REQUIREMENTS

Electric heaters shall be furnished and installed in accordance with NEC, OSHA, applicable local requirements and the manufacturer's instructions.

10125.4 METHOD OF MEASUREMENT**10125.4.1 NO MEASUREMENT**

Separate measurement for heaters will not be made when they are furnished and installed as components in a building or enclosure separately identified in the Bid Schedule.

10125.4.2 SEPARATE MEASUREMENT

Separate measurement will be made for heaters furnished and installed only when they are installed as replacement or separate items identified in the Bid Schedule.

10125.5 BASIS OF PAYMENT

Separate payment for heaters will not be made for heaters furnished and installed as equipment in a building or enclosure identified in the Bid Schedule.

The accepted quantity of heaters measured separately will be paid for at the contract unit price shown in the Bid Schedule for:

PAY ITEM	UNIT
Install <i>(Size) (Type)</i> Space Heater	Each
Replace <i>(Size) (Type)</i> Space Heater	Each

10210.1 DESCRIPTION

The Contractor shall furnish and install fans, louvers, dampers, and ventilators in designated buildings and equipment enclosures in accordance with the Drawings and these Specifications.

10210.1.1 RELATED WORK

Section 10125 - Electric Space Heaters
Section 16010 - Electrical System Requirements

10210.1.2 SUBMITTALS

The Contractor shall provide complete information, which includes cutaway drawings, parts lists, and capacity and manufacturer's installation instructions in accordance with the requirements of Section 01300.

10210.1.3 DEFINITIONS

Not used.

10210.2 MATERIALS**10210.2.1 QUALITY CONTROL**

This specification is not intended to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance. The Owner reserves the right to reject substitutions if in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

10210.2.2 FANS**10210.2.2.1 WALL FANS** - Wall fans shall be new, wall mounted, direct drive fans, mounted in a screened aluminum or steel frame suitable for mounting in an exterior opening. The fan propeller shall be statically and dynamically balanced cast aluminum, rated in accordance with the Air Movement and Control Association (AMCA), Certified Ratings Program, and fitted with ball type bearings. The fan shall have a spun steel venturi/wall base, and a heavy-duty steel power assembly. The fan shall also include an all aluminum motor operated backdraft damper and a ¼ inch by ¼ inch mesh 16 gauge aluminum screen on the inlet, and corrosion resistant fasteners.

The screening shall be removable for maintenance of the motor, and the unit shall be fitted with flanges around the exterior perimeter, which can provide a weather tight fit without additional moldings. The fan motor shall be capable of operating at standard power supply voltages from 110 through 480 volt, single phase or three phase as specified. All wall fans shall be UL listed and shall be manufactured in compliance with NEC and OSHA standards. Noise levels shall not exceed the maximum limits of Section 11010 of these Specifications.

When the Drawings call for wall fans and louvers to be mounted in wall openings, the louvers will typically be installed on the wall exterior to protect the fan. Both the louvers and the fan units should be removable or coordinated for convenient maintenance. Power actuated louvers shall be connected such that they open automatically when the fan is energized.

10210.2.2.2 TUBE FANS - Tube fans shall be new, direct drive, tube type fan units capable of being mounted directly in a circular pipe duct. The fan motor and housing shall be fabricated from corrosion

resistant steel, aluminum, or plastic and shall be capable of operating in both a vertical or horizontal orientation. The fan propeller shall be rated in accordance with the AMCA Certified Ratings Program. The fan shall have straightening vanes, which are heliarc welded at the discharge side of the unit to eliminate turbulence. The fan shall have a pre-wired twist lock disconnect, and the motor shall be out of the air-stream. The fan wheel shall incorporate true airfoil blades, which are heliarc welded to the hub with non-overloading characteristics. The fan support bracket shall include an extruded rubber isolator. The fan motor shall use ball bearings and shall be capable of operating on a 110 through 480 volt, single phase or three phase standard power supply, as specified. All tube fans shall be UL listed and shall be manufactured in compliance with NEC and OSHA standards. Noise levels shall not exceed the maximum limits of Section 11010 of these Specifications.

10210.2.3 LOUVERS AND DAMPERS

10210.2.3.1 **MECHANICALLY OPERATED LOUVERS** - Mechanically operated louvers shall be the type and size shown on the Drawings, and shall be as manufactured by the Airlite Company, Penn Ventilator Company, Vent Products Company, Inc., or approved equal. The frame and blades shall be 0.080 6063T5 extruded aluminum, with a standard mill finish, and the frames shall be formed to fit the openings. Blades shall be accurately fitted and firmly secured to the frames. The edges of all louver blades shall be folded or beaded for rigidity. The louvers shall include blade edge seals, and a flange mounting system, unless otherwise shown on the Drawings. Axles shall be ½-inch minimum diameter x 2-inch long plated steel rods. Bearings shall be ½-inch minimum diameter nylon. All louvers and dampers shall be furnished with ¼-inch by ¼-inch mesh 16-gauge aluminum bird screens in a standard folded frame, installed on the inside face of fixed louvers, on outside face for adjustable or automatic louvers, unless shown otherwise on the Drawings. Unless specified otherwise, mechanically operated louvers shall close automatically when the fan is not operating. Louvers shall receive a Class I anodized coating.

10210.2.3.2 **POWERED LOUVERS** - Where powered operators are required, the louvers shall be fully equipped and set up with the powered operators installed. Powered operators shall be sized as shown on the drawings and shall be as manufactured by Barber Coleman, or approved equal.

10210.2.3.3 **FIXED LOUVERS** - Galvanized steel fixed louvers shall be a complete factory assembled unit with stationary blades welded securely to the frame and of the size and configuration shown on the Drawings. Louvers shall be fabricated from 10 gauge galvanized steel sheet and fit with a #10 copper alloy insect screen soldered to the inside surface of the louvered opening. Unless shown otherwise in the CONTRACT DOCUMENTS, painting of galvanized louvers will not be required.

10210.2.3.4 **DOOR LOUVERS** - Door louvers shall be complete factory assembled, adjustable steel (19 gauge min.) door louvers with manually operated shutters, which can be closed tight. The louvers shall be fit with mounting brackets, which form a tight fit around the opening in the door. The louver shall incorporate a factory installed coating system. The color shall be as selected and approved by the OWNER. The louver shall be the model, size and configuration shown on the Drawings. When no size is shown on the Drawings, door louvers shall be 12 inches by 24 inches.

10210.2.4 ROOF VENTILATORS

10210.2.4.1 **POWERED ROOF VENTILATORS** - Powered roof ventilators for attic ventilation shall operate automatically on a thermostat that can be adjusted between 60°F and 120°F. The ventilators shall be sized as shown on the Drawings. The units shall include built-in safety firestats in the thermostat housings that will automatically shut off power to the units if the temperature reaches or exceeds 170°F, to prevent the vent from drawing in more air in the event of a fire. The units shall be of all metal construction of either galvanized steel, aluminum, or both. No plastic domes or flashing plates shall be used. The units shall incorporate an integral screen of 1/8-inch mesh

maximum, to keep out birds and large insects. Appropriate flashing and lap cement shall be installed to ensure that the vents are fully weatherproof.

10210.2.4.2 **WIND DRIVEN TURBINES** - Wind driven turbine roof ventilators installed to remove hot attic air and to prevent condensation under winter conditions, shall be 12-inch internally braced turbine ventilators, as shown on the Drawings. Ventilators shall be constructed of 24-gauge galvanized steel with an aluminum painted finish, and shall have ribbed blades for added strength. Turbine ventilators shall use hard chrome plated DuPont Delrin bearing systems, or approved equal. The ventilator shall be supplied with an integral automatic damper, designed to fit inside the 12-inch turbine base and turbine with base units. The damper shall be fully open at 90°F and shall be fully closed at 50°F. When installed on pitched roofs the ventilator shall employ an angle adjustable base, which will allow the ventilator to be installed with the axis of ventilator rotation plumb. Appropriate flashing and lap cement shall be installed to ensure that the vents are fully weatherproof.

10210.2.5 **TURBINE VENTILATORS FOR ROOM VENTILATION**

Wind driven turbine roof ventilators installed to circulate and vent warm air out of building spaces shall be 12-inch internally braced turbine ventilators, as shown on the Drawings. Ventilators shall be constructed of 24-gauge galvanized steel with an aluminum painted finish, and shall have ribbed blades for added strength. Turbine ventilators shall use hard chrome plated DuPont Delrin bearing systems, or approved equal. The ventilator shall be supplied with an integral thermally actuated automatic damper, designed to fit inside the 12-inch turbine base and turbine with base units. The damper shall be fully open at 90°F and shall be fully closed at 50°F. When installed on pitched roofs the ventilator shall employ an angle adjustable base, which will allow the ventilator to be installed with the axis of ventilator rotation plumb. Turbine roof ventilators used for room ventilation shall incorporate ductwork through the roof, attic spaces and ceiling. A factory painted aluminum or vinyl louvered grille shall be fastened to the ceiling to cover the duct opening in the ceiling. The louver shall closely match the interior ceiling colors. The ductwork shall be 24 gauge galvanized steel, minimum. Appropriate flashing and lap cement shall be installed to ensure that the vents are fully weatherproof.

10210.3 CONSTRUCTION REQUIREMENTS

Fans, louvers, dampers and ventilators shall be installed at the locations shown on the Drawings. Installations shall be in strict accordance with the manufacturer's installation instructions, NEC, OSHA, applicable local codes and requirements, the Drawings, and these Specifications. Wall openings shall be as shown on the Drawings.

Equipment installed in a concrete or masonry opening shall be mounted with expansion anchors through the frame or flange, or as otherwise detailed on the Drawings. Equipment installed in a wood framed opening shall be installed using lag screws or bolts, or as otherwise detailed on the Drawings. Where a caulked seal is required, ventilation equipment shall be provided with caulking stops. After installation, all joints between the equipment and the opening shall be caulked.

10210.4 METHOD OF MEASUREMENT

10210.4.1 **NO MEASUREMENT**

Unless a separate bid item for furnishing and installing the work outlined in this Section is provided in the Bid Schedule, this work shall not be measured for separate payment, but shall be considered incidental to other items in the Bid Schedule.

10210.4.2 SEPARATE MEASUREMENT

Where items installed under this section are listed separately in the Bid Schedule, the items shall be measured by counting the completed and accepted units.

10210.5 BASIS OF PAYMENT

Complete compensation for the accepted work outlined in this Section shall be included in other bid items when no separate bid item is provided in the Bid Schedule for this work.

When a separate bid item is provided in the Bid Schedule, complete compensation for this accepted work shall be included in the contract unit price on the Bid Schedule.

PAY ITEM	UNIT
Install (<i>Size</i>) (<i>Type</i>) Louvers	Each
Replace (<i>Size</i>) (<i>Type</i>) Louvers	Each
Install (<i>Size</i>) (<i>Type</i>) Fan	Each
Replace (<i>Size</i>) (<i>Type</i>) Fan	Each
Install (<i>Size</i>) (<i>Type</i>) Damper	Each
Replace (<i>Size</i>) (<i>Type</i>) Damper	Each
Install (<i>Size</i>) (<i>Type</i>) Roof Ventilator	Each
Replace (<i>Size</i>) (<i>Type</i>) Roof Ventilator	Each
Install (<i>Size</i>) (<i>Type</i>) Room Ventilator	Each
Replace (<i>Size</i>) (<i>Type</i>) Room Ventilator	Each

10400.1 DESCRIPTION

This section covers furnishing and installing safety and hand railings and their supporting fixtures, frames, and/or hardware in buildings or on other structures. Materials and locations of installation are to be as shown on the Drawings or required in these Specifications.

10400.1.1 RELATED WORK

Not used.

10400.1.2 SUBMITTALS

10400.1.2.1 DESCRIPTIVE INFORMATION - The Contractor shall provide descriptive information which shows detailed dimensions of rails and posts, material composition, details of fittings or anchors required for fastening, finishing, manufacturer's name, loading bearing capacity and manufacturer's installation instructions in accordance with the requirements of Section 01300.

10400.1.2.2 COMPLIANCE WITH STANDARDS - Evidence of these materials complying with applicable industrial safety standards shall be provided. In cases where a potential exists for the railing to serve public access, compliance with the Uniform Federal Accessibility Standards shall be required.

10400.1.3 DEFINITIONS

Not used.

10400.2 MATERIALS**10400.2.1 ALUMINUM RAILING**

Shall be extruded aluminum pipe with posts and fittings specifically manufactured for installation as handrails. Aluminum pipe materials shall have a minimum outside diameter of 2.0-inches. Spans between posts or mounting brackets shall not exceed 6-feet. Mounting screws and fasteners shall be stainless steel. Aluminum components of the railings shall be anodized and the railing shall be given a Class I architectural finish.

10400.2.2 FIBERGLASS RAILING

Shall be composite fiberglass with continuous glass fibers along the axial span and may be round or square tubing manufactured specifically for handrails. The resin used for the composition shall be fire retardant polyester. The color of the railings shall be yellow unless indicated otherwise by the Engineer. Railing installed where exposure to sunlight is possible, shall be provided with an ultraviolet (UV) light protection coating. Maintenance and repair instructions shall be provided to the Engineer with the submittal information indicated above. Metal hardware and materials furnished for mounting fiberglass handrails shall be stainless steel.

10400.2.3 STEEL PIPE RAILING

Shall be welded carbon steel pipe with posts and support fittings specifically manufactured for installation as handrails. Railing materials shall have a minimum outside diameter of 1.90-inches and a minimum wall thickness of 0.145-inches. Spans between posts or mounting brackets shall not exceed 6-feet. Mounting screws and fasteners shall be stainless steel. Following installation, all railings, posts and fittings shall be given two coats of gloss enamel epoxy paint of the color and as approved by the Engineer.

10400.2.4 TOP RAILINGS

Shall be continuous in sections up to 12-feet in length. When joints in the railings become necessary, they will be assembled tight and free from any sharp edges or burrs or nicks. All posts shall be single unspliced pipe lengths. Welds shall be ground smooth and finished to provide an uninterrupted surface.

10400.3 CONSTRUCTION REQUIREMENTS

Railing components shall be furnished from the same manufacturer and shall be installed in careful accordance with the manufacturer's instructions. All screwed or bolted fasteners shall be drawn up tight so that the completed railing is rigid and free of movements at joints and attachments.

10400.4 METHOD OF MEASUREMENT

10400.4.1 NO MEASUREMENT

No separate measurement shall be made for furnishing and installing railings when they are components of a structure or building shown on the Bid Schedule.

10400.4.2 SEPARATE MEASUREMENT

When shown as an item on the Bid Schedule, measurement shall be made for each linear foot of each type and configuration of railing furnished and installed. Such measurement shall include the posts and the supporting frame when normally furnished as a unit.

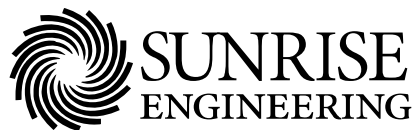
10400.5 BASIS OF PAYMENT

Separate payment for railings will not be made when they are furnished and installed as components in a building or enclosure identified in the Bid Schedule.

The accepted quantity of railings measured separately will be paid for at the contract unit price shown in the Bid Schedule for:

PAY ITEM	UNIT
<i>(Name) Railings (Size) (Type)</i>	Lineal Foot

DIVISION 11
PROCESS AND MECHANICAL EQUIPMENT



11010.1 DESCRIPTION

This section is included for guidance in the selection and installation of mechanical equipment. The requirements contained herein apply to all items of mechanical equipment the same as if these provisions were contained in the individual part of the Specifications for the equipment.

11010.1.1 RELATED WORK

Not used.

11010.1.2 SUBMITTALS**11010.1.2.1 SHOP DRAWINGS – Shop drawings shall be submitted as follows:**

- The Contractor shall submit Shop Drawings to the Engineer for approval on all mechanical equipment to be furnished under this Contract in accordance with Section 01300. The number of copies submitted shall be four, PLUS the number of copies the Contractor wishes to have returned.
- Prior to submitting the drawings, the Contractor shall review the information for completeness. Only complete information will be reviewed by the Engineer, and only after the Contractor has signified his approval of the information. Shop drawings will not be approved until cut-away or assembly drawings, with part and material specification lists, have been submitted.
- Shop drawings shall consist of a cover sheet which indicates intended use and data summary, outline drawings, cut-away drawings, parts lists, material specification lists, and all information required to substantiate that the proposed equipment meets the Specifications. In some special cases reproducible transparencies of Shop Drawings shall be furnished to the Engineer in addition to the above mentioned number of copies.
- Shop drawings for motors shall include published dimension sheets and shall include a motor data sheet which shows all the motor characteristics, i.e., horsepower, voltage, code letter, design letter, service factor, enclosure, insulation, etc. All characteristics of the motor shall be shown on the data sheet, which shall be approved by the Engineer prior to delivery of the motor.
- Shop drawings for pumps shall include make, style, speed, size, type, head-capacity, efficiency, materials used, design features, weights, etc. All characteristics of the pump shall be shown on the data sheet, which shall be approved by the Engineer prior to delivery.
- The Contractor shall assume the responsibility to ensure that approved guards for all drive units, pulleys, or rotating shafting are detailed on Shop Drawings and submitted with them to the Engineer for approval.

11010.1.2.2 PARTS CALCULATIONS AND DETAILS - The Contractor shall provide calculations and details on all parts individually and collectively to show that the equipment offered satisfies the performance, strength, vibration, and other requirements of these Specifications.

11010.1.2.3 GEAR REDUCTION UNITS - The Contractor shall submit complete engineering information, catalog data, design features, load capacities, and mechanical efficiency ratings for each gear reduction unit incorporated in the work. This information shall also be included in the equipment Operation and Maintenance Manuals, as described herein.

11010.1.2.4 OPERATION AND MAINTENANCE MANUALS - The Contractor shall furnish to the Owner four (4) copies of Operation and Maintenance (O & M) Manuals for each system or item in accordance with Section 01300 of these Specifications and as follows:

- O & M manuals shall be broken down into sections. The sections shall include Mechanical Equipment, Automatic and Special Valves, Control Systems, Electrical, and other additional sections as necessary. All sections shall be labeled and each item shall be sub-labeled. Each section shall include a description of the operation and maintenance of each item or component included in that section.
- There shall be included in the front of each manual an index laminated with plastic on both sides for protection against rough use.
- Each manual shall be bound in hard cover
- The manuals shall be delivered to the Owner prior to installation of any operating equipment.
- No acceptance of any equipment will be made until the complete manuals have been submitted, evaluated and approved.
- One copy of the complete manual shall be at the jobsite available for use by the Contractor's field personnel, the Owner, and the Engineer during installation, start-up and testing of the equipment.

11010.1.3 DEFINITIONS

Not used.

11010.2 EQUIPMENT

11010.2.1 QUALITY CONTROL

All equipment shall be the product of a manufacturer experienced in the design, construction, and operation of equipment for the purpose required. The manufacturer shall have furnished such equipment long enough to be able to show a record of successful operation for a period of not less than two years. When two or more units of equipment for the same purpose are required, they shall be products of the same manufacturer.

11010.2.2 MANUFACTURER'S GUARANTEE

Manufacturers or suppliers of all equipment furnished under this contract shall guarantee said equipment for a period of 1 full year from the date of Substantial Completion or Final Acceptance of the work in accordance with Section 00700.29 of these Specifications. Equipment shall be made up of parts which are designed to act as a unit; and the manufacturer shall guarantee that when the component parts are assembled into the final unit, these parts will fit and operate satisfactorily.

11010.2.3 ACCOMMODATION TO SEA LEVEL

The elevation of this project above sea level is shown on Drawings. Design and performance of all mechanical equipment shall conform thereto.

11010.2.4 GENERAL REQUIREMENTS

11010.2.4.1 HEAVY DUTY RATING - The manufacturer shall rate all mechanical items heavy duty. All parts of equipment shall be amply proportioned for all stresses, which may occur during operation and for any additional stresses, which may occur during fabrication and erection. Unless specified otherwise, all bearings shall be sized as a minimum for 100,000-hour service at maximum loading under AFMBA B-10 conditions.

11010.2.4.2 STEEL AND IRON - Structural steel shall conform to ASTM A 36. Iron castings shall be tough close-grained gray iron castings in accordance with ASTM A 48.

11010.2.4.3 FASTENERS - All fasteners for aluminum shall be stainless steel. All steel other than stainless steel shall be isolated from aluminum with stainless steel, neoprene, or other approved material.

11010.2.4.4 MODIFICATIONS TO PRODUCTION LINE EQUIPMENT - Modifications shall be made in manufacturer's equipment to make it conform to the specific requirements of the Drawings and Specifications, if the standard product does not fulfill all requirements.

11010.2.4.5 PRODUCTION LINE IMPROVEMENTS - All equipment shall include all production line improvements made prior to the contract or delivery date.

11010.2.5 MOTORS

11010.2.5.1 GENERAL - The purpose of this subsection is to identify and define premium quality electric motors having high electrical and mechanical integrity and energy efficient operation under adverse operating conditions to give maximum life and minimum life cycle costs.

11010.2.5.2 COMPLIANCE – Standards for motors are as follows:

- Motors shall be totally enclosed, either fan-cooled or non-ventilated, squirrel-cage induction motors, NEMA frame size 182T through 449T, as indicated on the Drawings or prescribed in the Special Provisions. Motors shall be Reliance XE or approved equal.
- All motors covered by this specification shall conform to the latest applicable requirements of NEMA, IEEE, ANSI, and NEC standards, including IEEE Std. 841.
- Motors shall be designed for continuous duty for 3-phase, 60 HZ, 200, 230, 230/460 or 575 volt operation, NEMA design B.
- Ratings shall be based on a 40°C ambient temperature and on operation at the given project altitude. Ratings shall provide for a maximum resistance temperature rise of 80°C at a service factor of 1.0, and a 90°C rise at a service factor of 1.15, through 150HP.
- Motors shall be furnished with Class F insulation, 1.15 service factor but shall be selected for operation within their full load rating without applying the service factor.
- Motors shall be of a premium efficient design and shall be different from the manufacturer's standard efficient product.
- Motors shall be evaluated on conformance to this specification and total costs including initial cost and operating life-cycle cost. Life-cycle cost to be based on motor efficiency evaluation at a stated dollar penalty per kilowatt of motor losses based on specific operating conditions.

- 11010.2.5.3 CONSTRUCTION - Motor rotor construction shall be die cast aluminum or fabricated copper or their respective alloys. Rotors on frames 213T and above shall be keyed to shaft and rotating assembly dynamically balanced to and .0005 inches peak to peak 182T-326T frames, and .00075 inches peak to peak 364T-449T frames. Balance weights, if required, shall be secured to the rotor resistance ring or fan blades by rivets. Machine screws and nuts are prohibited. The entire rotating assembly between bearing inner caps shall be coated with a corrosion-resistant epoxy.
- 11010.2.5.4 MECHANICAL – Mechanical requirements shall be as follows:
- Bearings shall be ball, open, single row deep groove, Conrad type, and shall have a Class 3 internal fit conforming to AFBMA Std. 20. For belted duty applications, drive end bearing may be cylindrical roller type.
 - Bearings shall be selected to provide L10 rating life of 17,500 hours minimum for belted applications, 100,000 hours minimum for flexible direct coupled applications. Calculations shall be based on external loads using NEMA belted applications limits per MG1-14.07 and typical sheave weights and internal loads defined by the manufacturer including magnetic pull and rotating assembly weight.
 - Bearing temperature rise at rated load shall not exceed 60°C 3600 RPM or 50°C 1800 RPM and slower. Temperature rise is to be measured by RTD or thermocouple at bearing outer race.
 - Bearing AFBMA identification number shall be stamped on motor nameplate.
 - Motor lubrication system shall consist of a grease inlet on motor bracket with capped grease fitting on inlet, grease relief plug 180 degree from inlet, grease reservoir in bracket and grease reservoir in cast inner cap.
 - Motor to be greased by manufacturer with a premium moisture resistant polyurea thickened grease containing rust inhibitors and suitable for operation over temperature from -25°C to 120°C.
 - Bearings shall be protected by INPRO/SEAL bearing isolators on both ends of the motor unless otherwise approved by the Engineer.
- 11010.2.5.5 ENCLOSURE – Motor enclosure including frame with integrally cast feet, end brackets, locking bearing inner caps, fan guards, and conduit box and cover shall be cast iron, ASTM Type A-48, Class 25 or better.
- 11010.2.5.6 CONDUIT BOX - Motor conduit box shall be cast iron construction; rotatable in 90-degree increments, diagonally split with tapped NPT threaded conduit entrance hole. Neoprene conduit box cover gasket and neoprene lead seal gasket between box and motor frame shall be furnished. The conduit box shall incorporate a mounted, clamp-type ground lug.
- 11010.2.5.7 COOLING FAN – The external cooling fan shall be corrosion-resistant, non-sparking, bi-directional, keyed, clamped and shouldered on the motor shaft.
- 11010.2.5.8 BREATHING DRAINS - Stainless steel automatic breather drains shall be provided in the lowest part of both front and back end brackets to allow drainage of condensation.

- 11010.2.5.9 MOUNTING HARDWARE - All mounting hardware shall be hex head, high strength, SAE Grade 5, plated for corrosion protection. Screwdriver slot fasteners are prohibited. A forged, steel, shouldered eyebolt shall be provided on all frames. Eyebolt receptacle shall be threaded and designed to prevent moisture or foreign material from entering motor when eyebolt is removed.
- 11010.2.5.10 NAMEPLATE - Corrosion resistant stainless steel nameplate shall be affixed to motor frame with stainless steel or brass drive pins. Nameplate(s) shall include all required NEMA data and AFBMA bearing numbers, and connection diagram for dual voltage motors.
- 11010.2.5.11 SHAFT SLINGER - An external V-ring shaft slinger shall be provided on both shaft extensions 254T and larger and on the drive end shaft only 182T-215T to minimize entrance of moisture or foreign material into bearing cavity.
- 11010.2.5.12 CORROSION PROTECTION - Frame to end bracket assembly of machined parts shall be protected and sealed by application of thick corrosion-resistant material to the machine surfaces prior to assembly.
- 11010.2.5.13 ELECTRICAL – Electrical requirements shall be as follows:
- All motors shall successfully operate under power supply variations per NEMA MG1-14.30.
 - All motors shall be NEMA Design B with torque and starting currents in accordance with NEMA MG1-12.35 and 12.38 except in special applications requiring higher starting torques where NEMA Design C is permitted.
 - Motors shall have copper windings.
 - Motor insulation system shall be Class F minimum, utilizing materials and insulation systems evaluated in accordance with IEEE 117 classification tests.
 - Motor leads shall be nonwicking type, Class F temperature rating or better and permanently numbered for identification.
 - The entire wound and insulated stator shall receive an additional coating of epoxy paint on all air gap surfaces, to protect against moisture and corrosion.
- 11010.2.5.14 FACTORY TESTING - Each completed and assembled motor shall receive a routine factory test per NEMA standards.
- 11010.2.5.15 NOISE - The no-load sound pressure level, based on the A-weighted scale at 3 feet when measured in accordance with IEEE Std. 85 should not exceed 85 DBA.
- 11010.2.5.16 EFFICIENCY - All motors shall be of an energy-efficient design, different from manufacturer's standard product through the use of premium materials, design and improved manufacturing process, that reduces motor losses approximately 40% from standard efficient designs, and whose minimum efficiencies exceed NEMA Table MG1-12.6C. Motor efficiency shall be determined in accordance with NEMA Standard MG1-12.54 and full load efficiency labeled on motor nameplate in accordance with NEMA Standard MG1-12.55.
- 11010.2.5.17 FINISH - All motor parts including frame, brackets, fan cover, and terminal box shall receive a minimum of two coats of high grade USDA accepted epoxy paint. Motor assembly must satisfactorily withstand salt spray tests for corrosion per ASTM B-117 for 96 hours.

11010.2.6 PUMPS

11010.2.6.1 **GENERAL** - The Contractor shall furnish, install, and test all pumps. Pumps shall be of heavy-duty construction for heavy-duty continuous service or for intermittent service, whichever imposes the most severe service on the pump. Pumps of inferior design or make will not be accepted.

11010.2.6.2 **MECHANICAL DEFECTS** - Mechanical defects shall include excessive vibration, improper balancing of any rotating parts, improper tolerances, binding, excessive motor heating, defective materials, improper fitting of parts, and any other defect which will in time damage the pump or pumps or unreasonably impair the efficiency of the pumps.

11010.2.6.3 **CAUSE FOR REJECTION** – Rejection of pumps for cause will be as follows:

- Pumps that have mechanical defects or do not meet the range of head-capacity characteristics, efficiency, and vibration requirements will be rejected and shall be replaced at the Contractor's full expense for furnishing, installing, removal, and replacement.
- If it is found upon delivery that the pump materials do not agree with the requirements of the Specifications as to size, type, quality, or metallurgy, they will be rejected as unfit for use on this project. Bronze or brass parts of any pump in contact with the pumped liquid shall contain no aluminum nor greater than six percent zinc.

11010.2.6.4 **FRICITION LOSSES** - Pump friction losses, including entrance, column, shaft, and discharge losses shall be added to the total dynamic heads that are specified under each pump in order to get the head that the impeller must pump against. Pump head-capacity curves shall indicate that these losses have been included.

11010.2.6.5 **PRESSURE GAUGES** - Pumps shall be tapped at the suction and discharge for pressure gauges. In general, all pumps that can be tested by pressure gauges shall be provided with suitable taps on both suction and discharge. Taps may be in pumps or in adjacent pipes within three inches of the pump flange.

11010.2.6.6 **TESTING** - Each and every pump, with its motor, drive, gearing, etc., shall be checked run, and tested at the place of manufacture. In addition, all pumps shall be volumetrically tested as to head-capacity requirements and for the purpose of cross checking the calibration of meters as required by the Engineer, after installation. Four certified laboratory performance curves for each pump shall be submitted to the Engineer for approval before shipment of the pump.

11010.2.7 MECHANICAL POWER TRANSMISSION EQUIPMENT

All mechanical power transmission equipment including V-belts, sheaves, chains, sprockets, mechanical variable speed drives, gear reducers, open and enclosed gearing, clutches, brakes shall be rated for 24-hour a day service and sized with a minimum service factor of 1.5. The 1.5 service factor shall be related to the nameplated HP and torque of the prime source of power and not the equipment actual loading. Should the manufacturer recommend a service factor larger than 50%, the manufacturer's recommendation shall take precedence.

11010.2.8 GEAR REDUCTION UNITS

11010.2.8.1 **CONSTRUCTION** - Unless otherwise specified, all gear reduction units shall be helical or herringbone type. No planetary gear units shall be used for any purpose, and worm gear type units may be used only where specified. Gears of gear reduction units shall be made of highest quality alloys treated for hardness and severe service. The complete reduction unit shall be fully enclosed

in a heavy cast iron housing with gears running in oil. All bearings shall be of the anti-friction type.

11010.2.8.2 CLASS OF SERVICE - Gear reduction units shall be selected for the class of service specified. The class of service must be determined by the manufacturer of the gear reduction units after being informed by the Contractor as to what equipment the units are to be used for and to what type of duty the equipment will be subjected. Where no class of service is specified, gear reduction unit class of service shall be Class II or heavier, as required, as classified by the American Gear Manufacturers Association.

11010.2.8.3 CAPACITY AND PERFORMANCE - The actual and rated horsepower capacity, torque, overhung capacity, and bearing capacity of each reduction unit shall be not less than the horsepower rating of the drive motor nor less than that which will be encountered under full load and under the most severe operating conditions which the equipment will be called upon to operate. The Engineer may reject any gear reduction unit that does not meet the above requirements. Only gear reduction units of long established manufacture and reputation may be used.

11010.2.9 SPECIAL TOOLS

All special tools that are required to assemble, disassemble, repair, and maintain any item of mechanical equipment shall be furnished with the equipment. Special tools shall include any type of tool that has been specifically made for use on an item of equipment for assembly, disassembly, repair, and maintenance. When special tools are provided, they shall be marked or tagged, and a list of such tools shall be included with the maintenance and operation instructions describing the use of each marked tool.

11010.2.10 LUBRICATION FITTINGS

All lubrication fittings shall be brought to the outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housing, or guards. Fittings shall be accessible from safe, permanent walk or walk areas without ladders, scaffolds, etc. Fittings shall be Lincoln "Bullneck" Hydraulic Surface Check Fittings (Lincoln Engineering Co., St. Louis, Missouri), or approved equivalent. Lubrication fittings shall be mounted together wherever possible. They shall not be individual fittings field mounted together, but use shall be made of factory-mounted multiple fitting assemblies located in convenient area. Connection from multiple fitting assemblies to point of use shall be minimum 3/16" stainless steel tubing, securely mounted parallel with equipment lines and protected where exposed to damage.

11010.2.11 MACHINERY AND EQUIPMENT GUARDS

11010.2.11.1 CONSTRUCTION AND INSTALLATION - All machinery drive units, pulleys, or rotating shafting shall be furnished with approved guards, shields, or barriers. Such guards, shields, or barriers shall be neatly and substantially constructed, adequately supported from adjacent framing. Guards shall be constructed of 6061-T6 aluminum unless otherwise indicated. The frame shall be covered with expanded aluminum for heat dissipation. All guards shall be isolated so no dissimilar metals come into contact.

All guards shall be sized to allow installation of pulleys up to and including 15 percent over size. The width of the guard shall be such as to allow one additional belt to be added in the future.

11010.2.11.2 COMPLIANCE - Guards shall be provided in all cases where required by state or OSHA or local codes. While all such guards may not be shown in detail on the Drawings, the Contractor is

expected to be familiar with the requirements of local, state, and federal regulations regarding machinery guards and safety devices.

11010.2.12 PAINTING

All equipment furnished for the project shall be painted in accordance with the requirements of Division 9 of these Specifications.

11010.3 EQUIPMENT CONSTRUCTION, INSTALLATION, AND TESTING**11010.3.1 GENERAL**

The furnishing and installation of equipment shall include testing, painting, checking levels and alignment, furnishing and placing of lubricants of whatever type, and furnishing of factory-trained service mechanics or engineers where called for. All equipment when finally installed shall be complete and ready for operation without binding or overloading of critical components or motors. The Contractor shall furnish at no extra cost to the Owner all appurtenances, piping, valves, fittings, wiring, supports, hangers, etc., as are required to place the equipment in first-class operating condition and in a near and workmanlike manner.

11010.3.2 INSTALLATION

11010.3.2.1 GENERAL - Equipment shall be installed complete and ready to operate by skilled craftsmen. Each craftsman employed to install a specific type of equipment shall be thoroughly trained in the particular trade required to install that equipment.

All moving parts of equipment and machinery shall be carefully installed, tested for operation, and adjusted so that all parts move freely and function to secure satisfactory operation.

11010.3.2.2 WELDING - Qualified welders in accordance with applicable welding codes and procedures shall perform all welding. Welding shall be by electric arc, unless otherwise shown on the Drawings or required by these Specifications.

11010.3.2.3 ANCHOR BOLTS - Anchor bolts for heavy equipment shall be encased in metal tubing having an inside diameter not less than two times that of the bolt, unless otherwise detailed on the Drawings. Foundations for pumps, motors and other equipment shall be left one inch below the grade of machine base unless otherwise required on the Drawings. After the proper setting of machine for alignment and grade, the recess below the equipment base, together with recess between the anchor bolt and the metal tube, shall be grouted and carefully finished with non shrink grout.

11010.3.2.4 PIPING - All piping required for proper operation of equipment shall be installed. Piping layouts may require modification from that shown on the Drawings depending on equipment furnished. All costs for piping or piping modifications required to suit the particular equipment furnished shall be borne by the Contractor.

11010.3.2.5 ELECTRICAL - Unless otherwise specified herein all electrical work, materials and equipment shall conform to the provisions of Division 16, Electrical of these Specifications. It shall be the responsibility of the Contractor to provide complete electrical systems sized to suit the equipment furnished and installed.

11010.3.2.6 ALIGNMENT OF MOTORS AND EQUIPMENT – Alignment of motors and equipment shall be as follows:

- In general, checking and correcting the alignment shall follow the procedures established in Section B (1X) of the Standards of the Hydraulic Institute, Instructions for Installation, Operation, and Maintenance of Centrifugal Pumps, as applicable.
- In all cases, the equipment shall be properly leveled and brought into angular and parallel alignment.
- Equipment bases shall not be grouted nor foundation bolts finally tightened until all piping connections are complete and in satisfactory alignment, such that no strain is transmitted to the equipment.
- In every case where a drive unit is connected to a driven piece of equipment by a flexible coupling, the coupling halves shall be disconnected and the alignment between the motor and the equipment checked and corrected after the complete unit has been leveled on its foundation. The alignment shall then be checked and corrected again after the grout has cured and the foundation bolts have been tightened.

11010.3.2.7 **GROUTING** – Grouting shall be performed as follows:

- Machinery shall first be perfectly aligned and leveled by means of steel wedges and shims near the anchor bolts. Anchor bolts shall be tightened against the shims on wedges before placing grout.
- Before grout placement, equipment foundations shall be prepared by chipping, hammering or sand blasting the entire concrete surface which will be grouted to remove any dirt or grease and to expose the concrete aggregate, unless approved otherwise by the Engineer.
- The equipment shall again be checked for level and alignment.
- The roughened foundation shall then be thoroughly cleaned, and the grout shall be thoroughly packed into place, filling all voids under the base of equipment.
- Special non-shrink grout shall be used in the placement of all heavy equipment and equipment bases. Non-shrink grout shall be as specified in Division 3 of these Specifications.
- Grout around all machinery bases shall be neatly pointed. All sandblast residue, grease, and debris shall be removed before any grout placement is started.

11010.3.3 **TESTING**

11010.3.3.1 **GENERAL** - Before testing, all equipment and mechanisms shall be filled by the Contractor with the proper amounts and types of oil and grease as recommended by the equipment manufacturer. The Contractor shall furnish all personnel, chemicals, and other necessary items as are required for the initial testing of equipment.

11010.3.3.2 **DURATION OF TEST** - Generally each piece of equipment, which in its normal use will operate for prolonged periods, shall be operated by the Contractor for at least 24 hours after installation, unless the Engineer is satisfied that a shorter test period is adequate. Satisfactory completion of this test does not relieve the Contractor of his responsibility in the event of binding, overloading, over-heating, or other equipment failure or malfunction after initial testing is performed.

11010.3.3.3 VIBRATION - The prime supplier shall make field tests for acceptable vibration in the on all pumps or other equipment with rotating shafts and/or a drive unit. Units shall be field tested for vibration after installation using the following process:

- All vibration testing shall be performed in the presence of and be witnessed by the Engineer. Testing shall be as required by the Engineer at various speeds between maximum and minimum. The Engineer shall be furnished a complete copy of vibration test data for each test performed.
- Each unit shall be tested separately with no other unit running.
- Drive systems, complete with motors, in place at the jobsite shall not vibrate more than 0.012 amplitude inch. Amplitude as used in this Section shall mean total peak-to-peak displacement, and it shall be measured by an IRD Vibration Meter, Model 306, or approved equal.
- All field tests shall be running tests with the drive unit driving the equipment.
- The equipment shall be free of static unbalance; shall be free of dynamic unbalance up to the maximum speed of the drive system; shall have the torsional critical speed 20 percent above the maximum speed of the pump and drive system.
- Vibration that occurs at the rotational critical speed shall not be greater than 0.012 amplitude inch; and shall be free of apparent unbalance caused by defective bearings, by close-fitting parts which may rub on the rotating parts intermittently, by loose discs or rotor parts, unbalanced loads, or by oil whip.
- Unless directed otherwise by the Engineer, vibration shall be measured at the top of the motor.

11010.3.3.4 NOISE LEVELS – Noise levels for the equipment and motors shall be measured in the field in accordance with AGMA 295.03. The combination equipment and motor, shall be designed to emit not more than 85 dBA when the measurements of the “C” network of the sound level meter are converted to “A” network readings or read directly on “A” network, unless otherwise specified. The manufacturer shall guarantee the sound levels specified. Enclosures built over the units are not acceptable as a means to meet specified sound levels. Each piece of equipment and its driver shall be tested through the range of possible operating speeds.

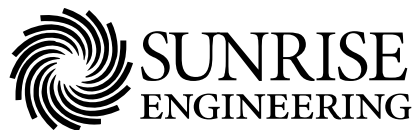
11010.4 METHOD OF MEASUREMENT

Not used.

11010.5 BASIS OF PAYMENT

Not used.

DIVISION 13
SPECIAL PROVISIONS



SPECIAL PROVISION

PRESSURE REDUCING VALVE VAULT

**SECTION
SP 13100**

13100.1 DESCRIPTION

The Contractor shall construct and install the PRV Vault and all appurtenances as show on the Drawings and as described in these Specifications.

13100.1.1 RELATED WORK

- 02201 – Earthwork for Structures
- 02222 – Water Pipe Installation
- 03050 – Portland Cement Concrete
- 03100 – Concrete Forming, Finishing and Curing
- 03200 – Concrete Reinforcement
- 03300 – Concrete Structures and Slabwork
- 03310 – Joints for Concrete Structures and Slabwork
- 03500 – Pre Cast Concrete Components
- 15110 – Pipe & Piping Systems
- 15230 – Waterline Valves & Hydrants
- 15232 – Water System Control Valves
- 15238 – Pressure Gauges

13100.2 MATERIALS

Information regarding the materials used will be found in their respective section of these Specifications.

13100.3 CONSTRUCTION REQUIREMENTS

13100.3.1 PRESSURE REDUCING VALVE VAULT

The Pressure Reducing Valve Vault shall be constructed in a workmanlike manner to achieve the desired result. The Contractor shall be responsible for installing all concrete components, piping, valves, fittings, controls, equipment and appurtenances as shown on the Drawings or as directed by the Engineer.

13100.4 METHOD OF MEASUREMENT

13100.4.1 PRESSURE REDUCING VALVE VAULT

Work completed under this bid item shall be measured by the lump sum. Such measurement shall include all equipment, labor, materials, and earthwork necessary to construct the Pressure Reducing Valve (PRV) Vault as shown on the Drawings. This includes but is not limited to concrete materials, piping, valves, fittings, controls, equipment and appurtenances as shown on the Drawings or as directed by the Engineer, including the gate valves shown upstream and downstream of the vault.

13100.5 BASIS OF PAYMENT

The accepted quantity of work will be paid for at the contract unit price for:

PAY ITEM	UNIT
PRV Vault	Lump Sum

13 34 21 SP
AWWA D115 CONCRETE TANK

1. GENERAL

1.1. DESCRIPTION:

- A. This section covers general requirements for construction of the post-tensioned concrete tank, including contractors' qualifications and construction procedure.
- B. Inform Engineer at least 72 hours in advance of time and places at which Contractor intends to place concrete. All preparation work for concrete placements shall be substantially completed at least 4 work-day hours prior to the scheduled start of concrete placement to allow for the Engineer's review and any necessary corrections.

1.2. QUALITY ASSURANCE:

- A. Reference standards.
 - 1. Except as noted or modified in this Section, all concrete materials, transporting, placing, finishing, and curing shall conform to requirements of the American Water Works Association (AWWA) D115 Standard for Circular Prestressed Concrete Water Tanks With Circumferential Tendons.
- B. Contractor shall keep at least one copy of above listed ACI publications, latest edition, in project field office at all times.
- C. Any material or operation specified by reference to the published specifications of a manufacturer shall be complied with unless directed otherwise by the Engineer.
- D. In case of a conflict between the referenced specifications or standards and this Specification, the one having the more stringent requirements, as determined by the Engineer, shall govern.

1.3. SUBMITTALS:

All submittals shall be made in accordance with Section 01 33 00. Submittal information includes, but is not necessarily limited to the following:

- A. Miscellaneous product information not otherwise specified in these Specifications.
- B. Proposed construction joints and procedures not consistent with these Specifications.

2. PRODUCTS (Not Applicable)

3. EXECUTION

3.1. TANK POST-TENSIONING AND CONSTRUCTION REQUIREMENTS:

- A. Description. The provisions covered by this section consist of special materials and procedures in connection with the construction of the circular concrete tanks in accordance with this Specification and Drawings.
- B. General. The tank shall conform to all applicable provisions of these Specifications and all applicable provisions of the American Water Works Association (AWWA) D115 Standard for Circular Prestressed Concrete Water Tanks with Circumferential Tendons.
- C. Guarantee. Two-year guarantee for Contract work shall be in accordance with the General Conditions.
- D. Procedure.
 - 1. Construct the wall footing and floor slab monolithically. The floor slab shall be constructed with only those construction joints shown on the drawings (if any). No construction joints in the floor slab will be allowed except as shown or reviewed by the Engineer. Floors, and roofs, shall be stressed in two stages as follows:
 - a. Post-tensioning operation shall not begin until maturity meters and field cured cylinders, or equivalent acceptable to the Engineer, have been tested and indicate that concrete has attained 1500 psi for the initial stressing of floor and roof slab tendons, 3000 psi for the final stressing of unbonded tendons and 3500 psi for bonded tendons in the wall, unless otherwise called for in the Contract Documents.
 - b. The floor and roof post-tensioning operation shall begin within 12 hours of when the maturity meters and cylinders have been tested and indicate that the concrete has attained 1500 psi, which shall be within 32 hours of the beginning of the placement of the concrete in the slabs. All tendons shall be stressed to 16 kips from one end (alternate stressing ends of two-end stressed tendons) within 48 hours of the beginning of the placement of the concrete in the slabs. Complete stressing of tendons to 33 kips when concrete compressive strength reaches 3,000 psi, which shall be within 7 days of the concrete placement. Submit the final elongation records to the Engineer for review within one day of completing the stressing and, as soon as possible, but within 7 days, after the review, remove stressing tails, place grease-filled end caps and grout pockets at stressing ends.
 - 2. Construct the column footings, columns, and wall. The tank requires a formed, cast-in-place concrete wall with horizontal and vertical post-tensioning tendons. The wall is left temporarily unconnected to the floor slab and wall footing by a sliding joint.
 - 3. Prestress the vertical tendons in the tank wall in proper sequence, if applicable.
 - 4. Prestress the horizontal tendons in the tank wall in the proper sequence. Submit the vertical and horizontal elongation records to the Engineer for review. As soon as possible after the review of the elongation records by the Engineer the horizontal and vertical wall tendons shall be grouted as applicable. Horizontal and grouted vertical tendons shall be grouted from

their lowest points until pure grout is ejecting from the tops of their standpipes at the high end.

The grouting operation shall be completed within 20 days of placing the prestressing steel in the ducts or special corrosion preventative measures acceptable to the Engineer, such as introducing a vapor-phase corrosion inhibitor into the ducts, shall be taken. Follow all safety recommendations of the manufacturer if vapor-phase corrosion inhibitors are used.

5. Construct the post-tensioned roof slab monolithically, without construction joints. No construction joints in the roof slab will be allowed except as shown or reviewed by the Engineer. Roofs shall be stressed in two stages, as described above.
 6. Place the waterstops and concrete in the curbs at the base of the wall. For circular tanks, and rectangular tanks with rounded corners, allow at least 28 days between the time the horizontal wall tendons are fully stressed and the concrete placing operation in the curbs is begun.
 7. Perform watertightness testing of the tank in accordance with Section 02676, "WATERTIGHTNESS TESTING."
 8. Backfill in accordance with Section 31 23 23, EARTHWORK of the Technical Specifications herein, and the Soils Engineer's recommendations.
- E. All tie holes, cut-outs, and block-outs, after being cleaned and a bonding agent applied, shall be filled with a non-shrink grout. Stressing tails shall be removed and block-outs patched as soon as practicable after review of the elongation records by the engineer, but not longer than 7 days.
- F. No welding or burning will be permitted in the vicinity of any tendons.

3.2. INTERNAL SURFACES AND COATINGS:

- A. All interior surfaces and coating of all equipment that comes in contact with drinking water to meet NSF/ANSI Standard 61 Certification requirements.
- B. Proper curing procedures shall be followed per the manufacturers' directions. Drinking water shall not be introduced into the tank until proper curing has occurred.
- C. Prior to placing a drinking water storage tank in service, an analysis for volatile organic compounds (VOC) from water contained therein may be required to verify compliance with drinking water maximum contaminant levels.
- D. Prior to placing a drinking water storage tank into service, cleaning, disinfection, and flushing procedures shall be completed.

3.3. TANK CLEANING AND DISINFECTING:

- A. After construction is completed, the interior of the tank shall be completely hosed out and cleaned of all dirt and loose material.
- B. The water storage tank shall be disinfected in accordance with the requirements of AWWA C652-11 prior to being placed into service. Test documentation shall be maintained in accordance with AWWA C652-11, APWA, and Contract.

3.4. BACKFILLING:

- A. Backfilling shall not begin until the tank is complete and has passed the watertightness tests.
- B. Backfill around tank wall shall be built-up in maximum 8-in. loose lifts and compacted as required. Heavy mechanical equipment shall not be allowed to compact backfill within 5 feet of the tank wall. Hand or light mechanical equipment (5,000 lbs. GVW max.) shall be used for compaction within this area.
- C. Heavy mechanical equipment shall not be allowed on the tank roof to place or compact backfill, if any. Hand or light mechanical equipment (10,000 lbs. GVW max.) shall be used in this area.

- END OF SECTION

SPECIAL PROVISION

CONCRETE WATER STORAGE TANK	SECTION SP 13310
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13310.1 DESCRIPTION

13310.1.1 The Contractor shall furnish all labor, equipment, and materials necessary to construct and erect a concrete water storage tank as shown on the Drawings, consisting of a concrete roof, concrete floor and a cast-in-place concrete wall. The tank shall conform to the dimensions and be equipped with the appurtenances, valves and piping within the pay limits for the tank, as shown on the Drawings and in accordance with these specifications.

13310.1.2 RELATED WORK

Section 02105 – Earthwork Materials
Section 02200 – Trench Excavation and Backfill
Section 02201 – Earthwork for Structures
Section 03050 – Portland Cement Concrete
Section 03100 – Concrete Forming, Finishing and Curing
Section 03200 – Concrete Reinforcement
Section 03300 – Concrete Structures and Slabwork
Section 03 11 01 SP – Water Stops
Section 03 11 02 SP – Post-Tensioning Tendons
Section 03 11 03 SP – Formwork for AWWA D115 Tank
Section 03 20 01 SP – Reinforcement for AWWA D115 Tank
Section 03 30 10 SP – Concrete Placement (Cold Weather Procedures)
Section 03 30 11 SP – Cast-In-Place Concrete for AWWA D115 Tank
Section 03 70 00 SP – Watertightness Testing of AWWA D115 Tank
Section 13 43 21 SP – AWWA D115 Concrete Tank

13310.1.3 SUBMITTALS

13310.1.3.1 Descriptive literature, which identifies the manufacturer and materials used for fabrication for all piping, valves, fittings, control valves, water stops, liners and appurtenances, shall be provided by the Contractor in accordance with Section 01300 of these Specifications.

13310.1.3.2 The Contractor shall submit a 2-foot minimum length of each type of closed cell neoprene pad for the tank lid joint and of the water stop material for inspection and acceptance testing, to ensure compliance with the requirements of these Specifications.

13310.1.3.3 The Contractor shall submit concrete mix design information along with certified strength test documentation for that design for approval by the Engineer at least two weeks prior to planned concrete placement.

13310.1.3.4 The Contractor shall submit test documentation required for culinary water systems for all tests and disinfection activities performed on the tank and its associated piping in accordance with the Standard Specifications (See Section 02222.3).

13310.2 MATERIALS

13310.2.1 CONCRETE, CONCRETE REINFORCING STEEL AND REINFORCEMENT SUPPORTS

13310.2.1.1 Concrete shall be furnished in accordance with Section 03050 of the Standard Specifications. Xypex®, Kryton®, or approved equal crystalline waterproofing admixture shall be included in the final concrete mix design for all concrete in the culinary water storage tank. The Contractor shall furnish a qualified factory representative to direct addition of the admixture at the batch plant. The

SPECIAL PROVISION

CONCRETE WATER STORAGE TANK	SECTION SP 13310
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admixture shall meet the factory recommended concentration. The Contractor shall be aware that the admixture may affect curing time for finishing.

13310.2.1.2 Concrete forms for use in tank construction shall be steel, clean, and in very good condition.

13310.2.1.3 Reinforcing steel shall comply with Standard Specifications Section 3200 with the following exceptions. Concrete reinforcement bar supports for this tank shall conform to ACI 315, and shall consist of stainless steel chairs, plastic spacers and/or plastic shim plates.

The stainless steel chairs shall be furnished with plastic tips where supports legs are in contact with forms on concrete surfaces exposed to view.

The plastic spacers shall be Preco Barspan Wheels, as manufactured by Preco Corporation (phone 1-800-645-1258) or approved equal.

Plastic shim plates may be used to support plastic spacers and shall be used to support vertical reinforcing in the core-wall for the tank, unless shown otherwise on the Drawings.

13310.2.2 MISCELLANEOUS COMPONENTS AND APPURTENANCES

13310.2.2.1 The tank access roof hatch shall include a fully enclosed curb and stainless steel hardware, of the type and size specified on the Drawings. It shall be sealed through the use of a caulked neoprene gasket and shall be fastened to the tank by means of eight 3/8" x 4" long stainless steel expansion anchors. The method of closure and closing hardware shall meet requirements of the Utah Department of Drinking Water.

13310.2.2.2 The air vents shall consist of a 8-inch diameter hot dip galvanized steel pipe fabricated as shown on the Drawings. The vent shall be provided with a ring seal embedded in the tank roof slab and a # 14 (1.4 mm) stainless steel screen installed as shown on the drawing details.

13310.2.2.3 Tank ladders shall be fabricated of steel as shown on the Drawings. Steel shall stainless steel type 304. All bolts and connectors shall be stainless steel type 316.

13310.2.2.4 Brackets and bands, which support and stabilize the piping, shall be fabricated from steel as shown on the Drawings. The brackets and bands shall be hot dipped galvanized after fabrication and all bolts and fasteners shall be stainless steel.

13310.2.2.5 Pipe and fittings embedded in the concrete tank shall be ductile iron with mechanical or flanged joints, meeting the requirements of Section 2222 of the Standard Specifications. The overflow stand pipe may be AWWA C900 PVC with ductile iron fittings. All joints shall be fastened with stainless steel bolts and hardware. The overflow funnel shall be fabricated of 1/8" minimum thickness 304 or 316 stainless steel and shall snugly fit the bell joint and gasket of the receiving pipe. A stainless steel pipe support bracket shall directly support the straight pipe section of the funnel above the point where it is inserted in the pipe bell. All joints on the overflow pipe and the funnel assembly shall be water tight. Pipe and fittings outside of the tank shall also meet the requirements of Section 2222 of the Standard Specifications and shall be of the material and in the configuration shown on the DRAWINGS.

13310.2.2.6 Gate valves, check valves, automatic control valves, air/vacuum relief valves and their boxes and enclosures shall be furnished and assembled in accordance with the Drawings and the Standard Specifications.

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13310.2.2.7 Prefabricated drainage panels to be installed prior to tank backfill, when required by the Drawings shall be furnished and installed in accordance with a separate Special Provisions Section.

13310.2.3 NSF COMPLIANCE

All materials, which will be in contact with culinary water after construction is completed and the tank is placed in service, including ladders into tanks and other components shall comply with National Sanitary Foundation (NSF) Standard 61.

13310.3 CONSTRUCTION

13310.3.1 EARTHWORK

13310.3.1.1 Earthwork shall be accomplished in accordance with Sections 02105 and 02201 of these Specifications.

13310.3.1.2 Unless directed otherwise by the Engineer, the entire site falling within the tank structural area shall be excavated to the lowest subgrade elevation, or to non-expansive bedrock, whichever is deeper, unless otherwise directed by the Engineer.

If site conditions are found to be different than expected (based on the geotechnical report), additional excavation may be required to provide adequate structural integrity for the tank. In lieu of or in addition to additional excavation, the Engineer may require the use of lean concrete as fill or foundation material for the tank. Additional requirements made by the Engineer as outlined in this paragraph shall constitute a changed condition, and the Contractor shall be compensated in accordance with Section 13 of the General Conditions.

13310.3.1.3 After preparation of the subgrade in accordance with Paragraph 2201.3.7 of the Standard Specifications, the Contractor shall place structural backfill material, in accordance with Section 02105, for the floor slab and tank footings as shown on the DRAWINGS. This material shall be placed in loose lifts not to exceed 8 inches and then compacted in accordance with Paragraph 2201.3.9 to 95% of maximum density. The finished thickness of the material shall be as shown on the DRAWINGS.

13310.3.1.4 Compaction required for all subgrade and earthwork materials used in tank construction, within the tank structural area, shall be 95% of maximum density unless directed otherwise by the Engineer. The tank structural area shall be that portion of the subgrade under the tank and 5 feet outside of the tank footing radius, unless otherwise shown on the DRAWINGS. Particular attention should be paid to compaction around footings. All compaction and testing shall be accomplished in accordance with Section 2201 of these SPECIFICATIONS.

13310.3.1.5 Unless directed otherwise by the Engineer, tank sites on hill slopes, on which embankment fills are to be placed, shall be terraced in a manner that all cuts are in bedrock or on subgrade materials approved by the Engineer. The "terracing" of slopes shall consist of near horizontal benches at least 4 feet wide and spaced vertically at a maximum of 2 feet intervals. The near horizontal benches shall be sloped 1.5 percent to provide natural drainage away from the slopes.

13310.3.1.6 The finished subgrade and grade of the structural fill under the floor and footings shall not vary more than minus 0.05 feet and plus 0.00 feet from the established grades and cross-sections shown on the DRAWINGS.

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13310.3.1.7 After pipe blocks have been formed and constructed and the forms for the pipe blocks have been removed, the areas under floor and footings and around pipe blocks that require structural granular fill shall be built up in 8 inch loose lifts. This material shall be compacted in accordance with the Standard Specifications until the finished elevations, shown on the DRAWINGS, have been reached.

In lieu of forming the pipe blocks, the structural granular fill may be completed to the required finished elevation after which the pipe blocks may be excavated. However, any loose or disturbed soil must be removed from the excavated areas and the compaction in the excavated areas must be rechecked for the required 95 percent minimum relative compaction under the supervision of a competent soils engineer.

13310.3.1.8 If excavation of the subgrade is in rock, any over-blasted or unsuitable material under the tank shall be removed. Unless otherwise directed by the Engineer, all over-blasted or over-excavated material shall be replaced with a lean concrete mix as defined below. When directed by the Engineer, lean concrete shall also be used to level the site and create the required slope to the outer perimeter ring drain, as applicable.

Lean concrete mix shall be prepared in accordance with requirements of Section 03050 for Portland cement concrete, but the mix shall use 3-sacks of Portland cement per yard of concrete mix. Lean concrete shall obtain a minimum compressive strength of 700 psi after 7 days when tested in accordance with Section 3050 of these SPECIFICATIONS.

13310.3.1.9 Backfill

- Backfill shall not be commenced until leakage testing has been satisfactorily completed. Backfill shall be accomplished in accordance with Section 2201, except as noted.
- As applicable, the Contractor shall take every precaution to avoid damaging or puncturing the prefabricated drainage composites or tank cover coating during back filling and compaction operations. Prefabricated drainage panels shall be adequately sealed at the top to prevent debris and dirt from entering behind the backfill material.
- Only lightweight hand operated compaction equipment shall be employed within 3 feet of the tank wall. This requirement will help to avoid any possibility that excessive pressure will develop on the walls, which could cause the structure to fracture. Compaction lifts shall be no thicker than can be properly compacted with the equipment used. The minimum compaction density for each lift shall be 90% at optimum moisture content for the full depth of the fill.

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13310.3.2 WATER STOPS

13310.3.2.1 Water stops shall be ribbed, having a hollow center bulb cross-section and they shall be uniform in dimensions and as detailed on the Drawings. Water stops shall be free of porosity and shall be made of a dense, homogeneous, virgin PVC compound. No reclaimed PVC shall be used in the compound. Water stops shall be by Vinylex Corporation, 2636 Byington-Solway Road, Knoxville, TN 37921 (ph. 615-690-2211), Greenstreak Plastic Products, Box 7139, St. Louis, MO 63177 (ph. 314-225-9400), or approved equal. Water stops shall meet the minimum material requirements of the table below.

WATER STOP MATERIAL SPECIFICATIONS		
Tensile Strength	2,000 PSI	(ASTM D-412)
Ultimate Elongation	350%	(ASTM D-412)
Shore Hardness	75 ± 5	(ASTM D-2240)
Specific Gravity	1.3	(ASTM D-792)
Stiffness in Flexure	600 PSI	(ASTM D-747)
Cold Brittleness	-35°F	(ASTM D-746)
Water Absorption: 48 Hours	0.320% (Max.)	(ASTM D-570)
Tear Resistance	290 pounds/inch	(ASTM D-624)

13310.3.2.2 Water stops shall be installed in the joints designated on the Drawings, with precautions taken to ensure proper location, support, and protection of the water stop during concrete placement.

Water stops shall be correctly positioned and held in place within the forms by using split forms, or other approved method that will positively hold the water stop in the correct position and alignment, so that the center of the water stop is centered on the joint. Horizontal water stops shall be bent up during concrete placement, until the concrete has been brought to the level of the water stop; additional concrete shall then be placed over the water stop, after which the concrete shall be thoroughly vibrated.

13310.3.2.3 All water stops shall be tied off in two directions every 12 inches in such a manner that bending over one way or another is prevented. In cases where preformed expansion joint material is used in conjunction with the water stop, allowance shall be made for equal water stop embedment on each side in the concrete. A hog ring or a nail may be driven through both ends of the water stop to facilitate placement and/or tying of water stops to reinforcing steel, forms, or form-ties.

13310.3.2.4 All water stops shall be properly spliced and joints shall be checked for strength and pinholes after splicing. Splices shall be strong enough to develop a pulling force of 75 percent of the strength of the water stop, and shall be watertight. The Contractor shall connect the ends of the radial water stop in the wall-footing joints to the circumferential water stop in the wall to wall-footing joint and to the circumferential water stops in the floor to wall-footing joints if they should exist.

13310.3.2.5 Section 03 11 01 SP will be followed in addition to this documentation with regards to Waterstops.

13310.3.3 CONCRETE

13310.3.3.1 Concrete work shall conform to the provisions of Division 03000 of the Standard Specifications as supplemented and modified by this Section. Concrete forms, reinforcement, concrete and tank appurtenances shall be located and placed as shown on the Drawings, and in accordance with Division 03000 of the Standard Specifications, unless noted otherwise herein.

13310.3.3.2 The proposed concrete mix design shall be submitted to the Engineer for review a minimum of two weeks in advance of the first planned concrete placement along with certified compression test

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results for that mix design. No concrete for the tank may be placed until the Engineer has approved the mix design.

13310.3.3.3 Prior to any concrete pour over 50 yards, a mandatory pre-pour meeting will be held and conducted by the Contractor. At a minimum the following people/ representatives are required to be there: concrete batch plant representative, lead for the vibration team/ efforts for the upcoming pour, a representative from the Engineer, the contractor supervisor or site lead, a representative from the material and testing company, and a representative from the pumping truck company. This meeting is to be held between 72 and 24 hours prior to the pour.

13310.3.3.4 When a pumper truck is required for the concrete pour and the volume of the pour is greater than 50 yards, at least two pump trucks will be on site for the pour with a third on call in the event of an emergency.

13310.3.4 TANK WALL TOP JOINT

13310.3.4.1 Neoprene bearing pads shall be of the dimensions and hardness shown on the Drawings, and shall be manufactured by an approved manufacturer. Unless otherwise specified on the Drawings, neoprene bearing pads shall be of 40 durometer and the material shall conform to ASTM D-2000 M2BC414A14C12F17. Where specified, material for 30 durometer neoprene pads shall conform to ASTM D-2000 M2BC310A14C12F17. Kirkhill Rubber Co., 300 East Cypress Street, Brea, CA 92621 (phone 714-529-4901, Construction Products Dept.) is one of several suppliers who can furnish neoprene pads meeting these requirements. Approved equal materials may be used.

13310.3.4.2 Closed cell neoprene pads shall be used as a filler material in the flexible joint between the wall and roof connection in the areas not taken up by the solid neoprene bearing pads. Closed cell neoprene shall be ordered at least 1/4 inch wider than theoretically required, to facilitate placing and to reduce development of voids between filler pads, bearing pads and water stops. The material shall be medium grade closed cell neoprene conforming to 2A3 of ASTM D-1056-85 and as further specified in the table below and on the Drawings. (Note: Rubatex R431N or R423N, or approved equal, are acceptable materials)

CLOSED CELL NEOPRENE PAD SPECIFICATIONS	
Compression Deflection	9 - 13 PSI
Shore 00 Durometer	60 - 80 PCF
Density	12 - PCF
Water Absorption By Weight	5%
Temperature Range:	
Low (Flex Without Cracking)	-30°F
High Continuous	150°F
High Intermittent	200°F
Heat Aging (7 days @ 158°F) Lineal Shrinkage (Max.)	5%
Tensile Strength	115 PSI (Min.)
Elongation	180% (Min.)
Resilience (Bayshore-% Rebound Average 1/2 inch Thickness at 72 °F)	20% - 40%

13310.3.4.3 All voids around bearing pads and cavities between bearing and filler pads whether these voids and cavities are large or small, shall be filled with soft mastic. The mastic material shall be installed at a consistency that will not adversely affect the quality of PVC and neoprene materials. The Contractor's workmanship shall be such that no cement grout or concrete seepage will occur through the bearing and filler pad areas. SIKAFLEX 1A, as manufactured by Sika Corporation or SELECT

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SEAL U-230, as manufactured by Select Products Company, or approved equal, are acceptable materials.

13310.3.4.4 Bearing and filler pads shall be installed as shown on the Drawings. They shall be glued to the concrete with an approved rubber cement material to prevent uplift of the pads during concrete placement. In addition, all pads shall be held down with approved plastic shim plates placed under the reinforcing steel. Nailing pads in place will not be permitted.

13310.3.5 SURFACE FINISHING

13310.3.5.1 The exterior surface shall receive a smooth finish in accordance with Section 03100.3.5.1 of the Standard Specifications, unless a color is to be applied to the tank. If a color is to be applied, the surface shall receive a grout cleaned, cork floated or other suitable rubbed finish with the color applied with the rubbing mixture as required.

13310.3.5.2 The interior tank floor and walls shall be smooth finished in the same manner as described above for the exterior surfaces and then cleaned and waterproofed.

13310.3.6 CLEANING AND WATERPROOFING

13310.3.6.1 After construction is completed, the interior of the tank shall be completely hosed out and cleaned of all dirt and loose material.

13310.3.6.2 If shrinkage cracking is observed on the floor surface, the floor shall be covered with a minimum of two inches of water and pure cement shall then be spread evenly over the entire floor area at the rate of one sack of cement to every 1,000 square feet of floor area. The floor shall not be allowed to dry after the application of cement.

Should repeated cement seeding fail to seal the floor cracks, each crack shall be pumped and sealed with a two-part water insensitive epoxy.

13310.3.7 DISINFECTING AND FILLING

13310.3.7.1 Water containing 200 ppm of chlorine shall be sprayed on all walls, columns and underside of roof areas. The solution from the wash down shall be allowed to stand for no more than 24 hours prior to filling the tank. Disinfection procedures shall conform to AWWA Standard C652-02 "Disinfection of Water Storage Facilities." Water used to disinfect the tank will be properly disposed of according to UAC R317.

13310.3.7.2 The chlorine shall be monitored and adjusted while filling, so that when the reservoir is full the resulting chlorine solution is approximately 2 ppm. The disinfection shall be accepted if samples taken for the final bacteriological test are found to be satisfactory. Testing documentation shall be maintained in accordance with the requirements of Section 02222.3.9 of these Specifications.

13310.3.7.3 The tank should only be filled during normal working hours, at the end of each day the reservoir and ring drain should be checked for any kind of visible leakage. If only damp spots and small puddles of water are noted, the filling can continue. If major leaks are noted, they should be thoroughly investigated prior to continuing to fill the tank.

13310.3.8 TESTING, LEAK REPAIR, AND ACCEPTANCE

13310.3.8.1 The overflow funnel and standpipe shall be tested for leakage before the tank is filled with water for the first time. Testing shall be accomplished by filling the overflow stand pipe to the top of the

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funnel and allowing it to stand for not less than 4 hours. The entire length of the standpipe from the top of the funnel to the floor of the tank shall be examined for leakage. Any leakage shall be permanently repaired and the standpipe shall be retested. Once the overflow standpipe and funnel system passes the leakage test, the tank can be filled for initial leakage testing.

13310.3.8.2 Testing of the tank shall be accomplished after filling the tank. The water level shall be held at the overflow for a period of 24 hours. The tank shall then be examined for evidence of leaks. All leaks shall be repaired to the satisfaction of the Engineer. Once all repair work is completed, the tank shall again be disinfected.

13310.3.8.3 Several leak detection methods are available to the CONTRACTOR. Any of these procedures may be required by the Engineer when cement seeding has not stopped the leaks. All chipped out concrete areas, resulting from leak repair, shall be properly dry-packed with a mix of 1 part cement to 2 parts coarse sand, after coating the existing bare concrete surface with an approved epoxy.

Leaks in the floor or floor to wall construction joints may be detected with the aid of a diver. Mud or cement deposits on the floor, when stirred up, would flow to the leak and may so indicate where the leaks are. Honeycomb and cracks around water stops may be detected through tapping with a hammer along the joint. Such leakage through joints, which may have resulted from bent over water stops or honeycomb under or around water stops, may require the removal of concrete around the water stops in suspected areas.

13310.3.8.4 The acceptable drop in water level of covered water tanks is described in Section 03 70 00 SP.

13310.3.9 PIPING AND APPURTENANCES

13310.3.9.1 The Contractor shall provide and install all piping, components, ladders, hatches, vents, and other appurtenances as required by these SPECIFICATIONS and as shown on the DRAWINGS, and shall make all connections as required on the tank drawings and details to provide a fully functional tank system.

13310.3.10 GRAVEL PARKING AREA

13310.3.10.1 The contractors shall install a gravel parking area on the tank site in accordance with the dimensions and cross section shown in the Drawings.

13310.3.11 ELECTRICAL

13310.3.11.1 The tank levels will be sensed by pressure transducers below the water surface in the tank. The readings from the pressure transducer will be transmitted to the existing SCADA system through the Valve Bunker. All communication is to be directly wired from the tank to the valve bunker for transmission. APCO is the current SCADA provider for North Logan. The contractor is to coordinate with APCO for the completion of the SCADA system. The contractor will be responsible for the electrical and SCADA components as provided in the Drawings. SCADA and electrical elements out side of the provided Drawings will be provided by APCO and/or North Logan

13310.3.11.2 All electrical components at the tank site will be powered by direct connection to the Rocky Mountain Power grid. The contractor shall install all components as shown on the drawings and make all electrical connections to the components at the tank site.

13310.3.12 VALVE BUNKER

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- 13310.3.12.1 The contractor shall make all connections of piping to the water storage tank. This connection includes the construction of a concrete bunker (known as the Valve Bunker) holding flow meters for the distribution and transmission lines and isolation gate valves to control the flow into and out of the water storage tank.
- 13310.3.12.2 The Valve Bunker shall be a cast in place concrete structure with the inside dimensions shown on the Drawings. The flow meters on the distribution and transmission line shall be Siemens Meters and will have direct power delivered to them. All the wiring to be performed in the Valve Bunker shall be planned to be run within the concrete walls, floor, and ceiling as appropriate. Wiring conduit will not be permitted to be mounted on the surface of the vault unless directly approved by the Engineer.
- 13310.3.12.2 The isolation valves for the tank shall be oriented on the distribution, transmission, and overflow lines as shown in the Drawings. Over the valves, meters and key fittings, a concrete embedded lifting eye is to be mounted into the Valve Bunker ceiling.

13310.4 METHOD OF MEASUREMENT

- 13310.4.1 Measurement of the 4.0 MG storage tank shall be lump sum and shall include all work and materials required, to construct the concrete water storage tank, its associated appurtenances, piping, valves and all other components within the pay limits described on the Drawings or in accordance with these Specifications. The pay limit for the tank is a 5' perimeter from the furthest edge of concrete for the tank.
- 13310.4.2 Measurement of the storage tank excavation shall be lump sum and shall include all excavation and grading for construction purposes of the entire tank building site as shown on the Drawings.
- 13310.4.2 Measurement of the storage tank structural fill shall be lump sum and shall include all earthwork activities required to acquire, import, place and compact the structural fill beneath the tank as shown on the Drawings.
- 13310.4.3 Measurement of the gravel parking area shall be lump sum and shall include all imported materials and grading necessary to build the parking area as shown on the Drawings.
- 13310.4.4 Measurement of the tank electrical work shall be lump sum and shall include the installation of the sensors, SCADA equipment, and all other electrical components as shown on the Drawings for the tank.
- 13310.4.2 Measurement of the bunker tank excavation shall be lump sum and shall include all excavation and grading for construction purposes of the entire valve bunker building site as shown on the Drawings.
- 13310.4.2 Measurement of the bunker structural fill shall be lump sum and shall include all earthwork activities required to acquire, import, place and compact the structural fill beneath the valve bunker as shown on the Drawings.
- 13310.4.5 Measurement of the concrete valve bunker shall be lump sum and shall include all work to produce a concrete structure as outlined in the Drawings for the purpose of housing the valves and pipes for the tank operation. This does not include the piping, valves, meters, electrical comments, and miscellaneous items inside the bunker.
- 13310.4.5 Measurement of the valve bunker piping, valves, and appurtenances shall be lump sum and shall include the procurement, and installation of the piping, valves, meters, and miscellaneous elements

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and appurtenances as shown in the Drawings. The pay limit for this item is within 5' of the exterior perimeter.

13310.4.4 Measurement of the valve bunker electrical work shall be lump sum and shall include the installation of the sensors, SCADA equipment, general electrical elements, the heater and other mechanical items, the electrical service for the site, and all other electrical components as shown on the Drawings for the valve bunker.

13310.4.2 Measurement of the tank site back fill and site grading shall be lump sum and shall include all earthwork to complete the final grade around the tank, valve bunker, and surrounding area as shown on the Drawings.

13310.4.2 Measurement of the tank site re-seeding and erosion control shall be lump sum and shall include all efforts and materials to re-seed the site with the approved seed mixture using a hydro seed method. This also includes the erosion control measures as shown in the Drawings utilizing straw wattles.

13310.4.2 The Contractor shall make its own computations for ordering concrete and other materials.

13310.4.3 No measurement will be made for concrete required to fill over excavation for footings, walls or slabs.

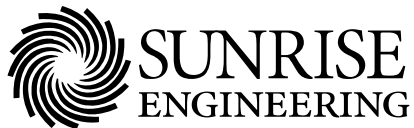
13310.4.4 No deduction will be required for concrete volume occupied by piping, reinforcing steel, anchors, hatches or man-ways.

13310.5 BASIS OF PAYMENT

13310.5.1 The accepted quantities will be paid for at the contract unit prices for:

PAY ITEM	UNIT
4.0 MG Concrete AWWA D115 Water Storage Tank	Lump Sum
Tank Excavation	Lump Sum
Tank Structural Fill	Lump Sum
Tank Electrical	Lump Sum
Bunker Excavation	Lump Sum
Bunker Structural Fill	Lump Sum
Concrete Valve Bunker	Lump Sum
Bunker Piping, Valves, and Appurtenances	Lump Sum
Bunker Electrical	Lump Sum
Tank Site Back Fill and Site Grading	Lump Sum
Tank Site Re-Seeding and Erosion Control	Lump Sum

DIVISION 15
MECHANICAL



15110.1 DESCRIPTION

This section is a materials specification and is included for guidance in selecting materials for pipe and related fittings and appurtenances used in the construction of water and sewer systems.

15110.1.1 RELATED WORK

Section 02222 - Waterline Pipe Installation
Section 02224 - Sewer Line Pipe and Manhole Installation
Section 15230 - Waterline Valves and Hydrants
Section 15232 - Water System Control Valves

15110.1.2 SUBMITTALS

The Contractor shall submit for review complete information, showing all pipe, materials, fittings, gaskets, couplings, coatings, linings, supports, mechanical restraints, thrust blocks and configuration prior to the delivery of any components to the project. All information shall be provided in accordance with Section 01300 and written evidence of compliance from the manufacturer shall accompany each delivery of material.

15110.1.3 DEFINITIONS

Not used.

15110.2 MATERIALS**15110.2.1 NSF COMPLIANCE**

All pipe and materials furnished and installed for culinary use shall comply with NSF International Standard 61. Also, all plastic pipe must be approved by the NSF for potable water use and shall carry the factory "NSF" stamped label on the pipe indicating such approval.

15110.2.2 POLYVINYL CHLORIDE PIPE (PVC)**15110.2.2.1 PVC PIPE FOR WATER LINE CONSTRUCTION – Shall be as follows:**

- For sizes less than 4 inches OD, PVC pipe shall be Schedule Rated pressure pipe meeting the requirements of ASTM D1785 of the schedule and size shown on the Drawings.
- PVC pipe 4 inches and larger, shall be rigid, thermoplastic Class Rated pressure pipe meeting the requirements of ANSI/AWWA Standard C900 or C905 (latest revision). The pressure class or the dimensional ratio and the size shall be as shown on the Drawings.
- While Class Rated and Pressure Rated pipe materials are not interchangeable, when specifically allowed in the Contract Documents, for size 4" and larger, rigid thermoplastic Pressure Rated pressure pipe, meeting the requirements of ASTM D2241, may be furnished and installed. Operating pressure for this pipe shall be as shown on the Drawings.

15110.2.2.2 FITTINGS FOR PVC PIPE – Unless specifically authorized otherwise, fittings for 4 inch and larger size PVC pipe in underground service shall be ductile iron (DI) and shall meet the requirements of NSF 61 and ANSI/AWWA C-153. They shall have a standard coating of cement mortar on the interior surfaces in compliances with AWWA C-104. DI fittings meeting these requirements may be used with smaller PVC piping. PVC fittings meeting the requirements of ANSI/AWWA C-907 may be used with PVC pipe smaller than 4 inches, and, in some instances, where specifically authorized, with PVC pipe sizes 4 inches through 8-inches.

15110.2.3 DUCTILE IRON PIPE

15110.2.3.1 INTERIOR COATING - The interior surface of all DI pipe shall be coated with a standard coating of cement-mortar in accordance with ANSI/AWWA Standard C-104 unless required otherwise in the Contract Documents. Field coating of DI pipe will not be acceptable.

15110.2.3.2 BURIED PIPE – Unless shown otherwise on the Drawings, shall be as follows:

- Buried ductile iron pipe shall be Thickness Class 51.
- Shall meet requirements of ANSI/AWWA C-151.
- Joints shall be bell and spigot or mechanical, which meet the requirements of ANSI/AWWA C-111.

15110.2.3.3 EXPOSED PIPE – Shall meet these requirements, unless shown otherwise on the Drawings:

- Exposed ductile iron pipe shall be Thickness Class 53.
- Pipe shall comply with ANSI/AWWA Standard C-151.
- Pipe joints shall be flanged, meeting the requirements of ANSI/AWWA C-115, or mechanical type couplings (MTC), meeting the requirements of ANSI/AWWA C-606. MTC shall be Victaulic grooved couplings, as manufactured by Victaulic Company of America or approved equal), unless shown otherwise on the drawings.
- 3” to 12” compact flanged fittings shall be ductile iron and shall be produced in accordance with laying lengths specified in ANSI/AWWA C110/A21.10. Flange surface shall be faced and drilled in accordance with ANSI Class 125 B16.1. Nominal body thickness shall be Manufacturer’s Standard, but shall not be less than those specified in ANSI/AWWA C153/A21.53 “Standards for Ductile Iron Compact Fittings”. Flange thickness shall be in accordance with the Manufacturer’s Standards. Working pressure rating shall be 250 psi for water. Fittings shall be made in the United States of America and shall not have been refurbished or reworked by anyone other than the manufacturer. When greater than 250 psi is called for on the Plans, then the Supplier shall furnish higher class rated flanges. Standard Class 125 template for drilling shall be used for all flanges. Drilling templates shall be in multiples of four, so that fittings may be made to face in any quarter. Boltholes shall straddle the centerline and shall be equally spaced. Misalignment of boltholes of two opposing flanges shall not exceed 0.12 inches. Blind flanges 12 inches and over shall be provided with lifting eyes. Insulated flanges shall be provided where required.
- Gaskets shall be full faced, 1/16-inch thick compressed sheets of Aramid fiber base, with nitrile binder and non stick coating, suitable for temperatures to 700°, pressures to 1000 psig and a pH range of 1 to 11. Blind flange gaskets shall cover the entire inside face of the flange and shall be cemented in place. Gaskets shall be as manufactured by John Crane, style 2160; Garlock, style 3000; or approved equal.

15110.2.4 HIGH DENSITY POLYETHYLENE PIPE (HDPE)

15110.2.4.1 PIPE – Shall be as follows:

- PE pipe shall be classified as 445574C, according to ASTM D3350. All PE pipe shall be manufactured according to AWWA C906 and ASTM D3035, F714. For oil and gas piping, PE pipe shall be per API 15LE.

- Pipe shall be made of high density, high molecular weight resin. PE plastic shall have a cell classification of 445574C as defined by ASTM D3350/AWWA C906. It shall be rated as PE4710 according to the requirements of the Plastics Pipe Institute. Internal pressure rating shall be as specified elsewhere in the project documents.

15110.2.4.2 FITTINGS FOR HDPE – Molded fittings shall be made of pre-blended virgin resins in accordance with the materials specifications of ASTM D3350. PE plastic fittings shall have a cell classification of 445574C as defined by ASTM D3350/AWWA C906. Socket fusion fittings shall be manufactured in compliance with ASTM D2683 and butt fusion fittings with ASTM D3261. Measurements of fittings shall be as required by ASTM D2122. All fittings shall be compatible for heat fusion with any pipe manufactured for like or similar resins.

Heat welded Flange Adapter Couplings shall be used for transition to other type piping material. The Contractor shall follow the manufacturer's recommendations, as well as specified procedures herein in fusing fittings to the polyethylene pipe.

15110.2.5 GALVANIZED IRON PIPE AND FITTINGS

Shall be of the schedule rating shown on the Drawings and shall be used only in exposed, non-corrosive atmospheres where piping diameters are less than 4 inches.

15110.2.6 PIPE AND FITTINGS FOR WATER SERVICE LINES

Shall meet the requirements provided in Section 15234 for water service connections.

15110.2.7 PIPE FOR GRAVITY SEWER SYSTEMS

Gravity sewer pipelines may be constructed with PVC or polyethylene (PE) plastic sewer pipe and fittings. Such materials shall be of the type, configuration and size shown on the Drawings and/or on the Bid Schedule.

15110.2.7.1 PVC PIPE - All PVC sewer pipe and fittings shall meet the standards of ASTM D3034 and F679. Such pipe shall be manufactured with a rubber gasketed joining system which meets ASTM D3212 and shall be furnished with a standard dimensional ratio of 35 (SDR 35) for wall thickness, unless shown otherwise on the Drawings.

15110.2.7.2 PE PIPE - All PE sewer pipe shall be smooth, solid wall, high density polyethylene pipe manufactured from PE 4710 material conforming to ASTM D3350 cell classification 445574C rating from the Plastic Pipe Institute. Fittings for this pipe shall be molded from a polyethylene compound equal to or exceeding the properties of the pipe being supplied.

15110.2.8 PIPE FOR PRESSURE SEWER SYSTEMS

Pressure sewer pipelines shall be constructed with DI, PVC, or PE plastic sewer pipe. Fittings and materials shall be of the type, SDR rating, (or pressure class) and size shown on the Drawings and/or on the Bid Schedule.

15110.2.8.1 PVC PIPE - All PVC pipe for pressure sewer lines shall be rigid, pressure rated, thermoplastic pipe which meets the standards of ASTM D2241. Fittings for PVC pipelines shall be Class 50, cement mortar lined, rubber gasketed, DI which meet the requirements of ANSI/AWWA C-153 and C-104.

15110.2.8.2 PE PIPE - PE pipe for pressure sewer lines shall be smooth, solid wall, high density polyethylene pipe manufactured from PE 4710 material conforming to ASTM D3350 cell classification 445574C

rating from the Plastic Pipe Institute. Fittings for this pipe shall be molded from a polyethylene compound equal to or exceeding the properties of the pipe being supplied.

15110.2.9 PIPE AND FITTINGS FOR IRRIGATION SYSTEMS

Pipe and fitting for irrigation systems shall be either DI or Pressure Rated PVC, of the type and class shown on the Drawings, for line diameters 4-inches and greater. Buried lines smaller than 4 inches in diameter shall be Schedule Rated PVC as shown on the Drawings.

15110.2.10 PIPE FOR DRAIN SYSTEMS

Piping for sub-drainage may be constructed with polyvinyl chloride (PVC) or polyethylene (PE) plastic non-pressure drainage or sewer pipe and fittings. Such materials shall be of the type, configuration and size shown on the Drawings and/or on the Bid Schedule.

15110.2.10.1 PVC PIPE - All PVC drainage pipe and fittings shall meet the standards of ASTM F794. Such pipe shall be manufactured with a rubber gasketed joining system which meets ASTM D3212 and may be furnished with ribbed, corrugated or smooth exterior walls with smooth interior wall surfaces, unless shown otherwise on the Drawings. Rubber gasketed joints will not be required for collection pipe applications with perforated or slotted pipe sections.

15110.2.10.2 PE PIPE - All PE drainage pipe shall be solid, corrugated or ribbed wall high-density polyethylene pipe with smooth interior wall surfaces. Material shall be PE 4710 material conforming to ASTM D3350 cell classification 445574C rating from the Plastic Pipe Institute. Fittings for this pipe shall be molded from a polyethylene compound and with equivalent properties and configurations specifically designed to fit the pipe being supplied.

15110.2.11 MISCELLANEOUS FITTINGS AND MATERIALS

15110.2.11.1 PIPE SUPPORTS - Floor mounted pipe supports for suspended, exposed piping systems shall be adjustable stanchion type supports designed to cradle the pipe diameter by 170 degrees. The support shall fit ductile iron or steel diameters snugly, without excessive gaps between the support and the pipe. Support saddle width shall be a minimum of 2 inches wide. The support must offer a minimum of 3 inches of final adjustment, after installation. Supports shall be supplied with independent base and adjustment collar designed to accept standard sized Schedule 40 galvanized steel pipe for coarse adjustment. Supports shall be fabricated from A36 mild steel, and shall have an electro-galvanized finish. Floor mounted pipe supports shall be the Standon Model S92 or C92 as manufactured by Material Resources, Inc., 22700 N. W. Quatama Street, Hillsboro, Oregon 97124, or approved equal. The standard required model shall be the S92. Non standard materials or model numbers shall be as specified on the Drawings.

15110.2.11.2 "Y" STRAINERS - shall be constructed of high-tensile ASTM A126 Class B Cast Iron with blow-off connections and self-aligning cylindrical screens and shall be equal to Watts Regulator Series 77F or better quality.

15110.2.11.3 FASTENERS – Fastener requirements are as follows:

- Unless otherwise required in these Specifications or shown on the Drawings, all bolting hardware for buried pipe, fittings, valves, and components shall be of manufacturer's standard materials.
- Unless otherwise required in these Specifications or shown on the Drawings, all bolting materials for exposed pipe, fittings, valves, and components shall be Type 316 stainless steel. Where space restrictions preclude the use of regular bolts, stainless steel threaded studs may be used on all valve flange connections.

- In all instances where stainless steel threaded fasteners are used, a coating of an approved, permanent anti-seize compound shall be applied to the fastener to prevent galling and to assist in disassembly.
- All bolts and/or studs shall extend through the nuts at least 1/4 inch.

15110.2.11.4 COUPLINGS – Couplings shall meet the following requirements:

- Unless prescribed otherwise on the Drawings or in these Specifications, couplings shall meet the requirements of ANSI/AWWA C-219. All flexible couplings shall meet the minimum requirements of Smith Blair 400 series.
- Sleeves shall have a smooth inside taper and there shall be no surface irregularities on any sealing surface. Gaskets shall be suitable for the project application.
- Flexible couplings for buried DI and PVC pipe sizes 2 through 16 inches in diameter shall be fabricated of steel or ductile iron. For pipe sizes larger than 16 inches, flexible couplings shall be of steel. Coupling components for use in potable water systems shall be factory coated with an FDA approved, bonded epoxy coating, applied to an average 12 mil thickness.
- Flexible couplings for exposed pipe shall be manufactured of steel, unless shown otherwise on the Drawings, or approved by the Engineer. Coupling components for use in potable water systems shall be factory coated with an FDA approved, fusion-bonded epoxy coating, applied to an average 12 mil thickness.

15110.2.11.5 RESTRAINT HARNESS – Where required, restraint harness for bell and spigot pipe joints shall be as manufactured by EBAA Iron Co. or an approved equal. The restraint shall consist of a split bell ring to go behind the bell and a split, serrated ring to grip the pipe on the other side of the joint. The harness shall be held together with clamping bolts and tie bolts. The rings shall be fabricated of 60-42-10 DI conforming to ASTM A-536. Clamping bolts shall be grade 5 zinc coated machine bolts. Tie bolts are of low alloy steel. The harness shall have a minimum working pressure of 150 psi. Harness size shall be as shown in the schedule on the Drawings or as specified in the Special Provisions.

15110.2.11.6 VALVES AND FITTINGS - Shall be as specified in their respective sections in these Specifications.

15110.2.11.7 BOXES AND ENCLOSURES – Shall be of the size, type, and configuration indicated on the Drawings and Contract Documents.

15110.3 CONSTRUCTION REQUIREMENTS

See Sections 02222 and 02224 for construction requirements for applicable piping systems.

15110.4 METHOD OF MEASUREMENT

In general, fittings for pipe and piping systems are, and will be, considered appurtenant to the pipeline being installed unless specifically called out for separate payment on the Bid Schedule.

15110.5 BASIS OF PAYMENT

Not used.

15230.1 DESCRIPTION

This section covers furnishing and installing valves and fire hydrants in water transmission and distribution lines, together with fittings, thrust blocking, and boxes and enclosures related to the operating equipment.

15230.1.1 RELATED WORK

Section 02222 - Waterline Pipe Installation
Section 15110 - Pipe and Piping Systems
Section 15232 - Water System Control Valves

15230.1.2 SUBMITTALS

All information shall be provided in accordance with Section 01300. Written evidence of compliance from the manufacturer shall accompany each delivery of material.

15230.1.2.1 VALVES 12 INCHES AND SMALLER, AND HYDRANTS - For valve sizes 12-inches and smaller, and fire hydrants, the Contractor shall furnish the manufacturer's standard data and catalogues for review and approval.

15230.1.2.2 VALVES LARGER THAN 12 INCHES - For all valves sized larger than 12-inches, the Contractor shall furnish shop drawings and technical data prepared by the manufacturer for review and approval.

15230.1.2.3 CONTENT - Submittals shall include complete details, dimensions, weights, diameter of stems, alloy for all valve parts and any information that may be required to assemble, install, operate and maintain the valve.

15230.1.2.4 BUTTERFLY VALVES - Certification of performance together with leakage and hydrostatic tests as described in Section 13 of ASTM/AWWA C-504 shall be furnished to the Engineer upon the Engineer's request.

15230.1.2.5 BALL VALVES - Certification of performance together with leakage and hydrostatic tests as described in Section 5 of ASTM/AWWA C-507, shall be furnished to the Engineer upon the Engineer's request.

15230.1.3 DEFINITIONS

Not used.

15230.2 MATERIALS**15230.2.1 GATE VALVES**

15230.2.1.1 COMPLIANCE - All gate valves shall conform to AWWA C-500 or C-509 with the following characteristics:

15230.2.1.2 3-INCH AND SMALLER VALVES - Valves 3-inches and smaller shall be as follows:

- Valves shall be as manufactured by Ford, Hayes, Mueller, Red & White, or an approved equal.
- Valves shall be standard, double-disc, non-rising stem valves with wheel handles.
- Valve bodies shall be all bronze or brass.

- Valves shall be threaded, unless shown otherwise on the Drawings or required in these Specifications.

15230.2.1.3 GATE VALVES 4-INCH THROUGH 14-INCH - Gate valves 4-inches through 14-inches in size shall be as follows:

- Valves shall have a ductile iron body.
- Valves shall have a solid cast iron, rubber coated, wedge gate and a resilient seat.
- Gate shall be designed to work equally well with pressure on either side of it.
- Valves shall be of the non-rising stem type and shall be left hand opening (counter-clockwise) with a 2-inch square operating nut.
- All interior ferrous surfaces exposed to fluid flow shall have an NSF approved, fusion bonded, epoxy coating. Epoxy coatings shall be factory applied by an electrostatic or thermosetting process.

15230.2.1.4 GATE VALVES 16-INCHES AND LARGER - Gate valves 16-inches and larger shall be as follows:

- Valves shall be double-disc gate valves with flanged ends.
- Valves shall be manufactured in accordance with AWWA C-500. Bolts, nuts, studs, etc., used with the gear case also shall conform to the requirements for Bonnet Bolting in AWWA C-500.
- Valves shall have bevel gears and shall be actuated by 2-inch square operating nuts.
- The gears and stuffing box shall be enclosed in a watertight cast or ductile iron case for operation in buried location.
- The case shall be filled with grease at the factory.
- Valves shall be designed to operate in a horizontal orientation.
- Valves shall be equipped with bronze tracks, rollers and scrapers.
- By-pass valves shall be furnished with each valve mounted in position A as indicated in AWWA C-500.

15230.2.1.5 VALVES ON WATER MAINS - Valves on water mains shall have the following features:

- In-line valves shall have push-on or mechanical joints conforming to AWWA C-111.
- Valves attached to side outlets shall be flanged.
- By-pass valves shall be flanged.
- Valves in blow-off lines shall be flanged.
- Valves in fire hydrant lines shall have push-on or mechanical joints.
- Valves in air release and vacuum relief lines shall be flanged or threaded.

- Valves 12-inches and smaller shall be equipped with O-ring packing.

15230.2.2 BUTTERFLY VALVES

15230.2.2.1 **MANUFACTURER** - Butterfly valves shall be Dresser Industries "450", Allis-Chalmers "Streamseal", Henry Pratt "Groundhog", Mueller Linesal III, or an approved equal.

15230.2.2.2 **COMPLIANCE** - Butterfly valves shall conform to AWWA C-504.

15230.2.2.3 **CLASS** - Valves shall be Class 150 seated, tight closing valves, furnished with mechanical or flanged joints

15230.2.2.4 **SEATS** - Rubber valve seats shall be replaceable without disassembling the valve and shall not be interrupted by the shafting. Rubber seats may be retained on the disc edge by stainless steel clamping in lieu of bonding to the valve body.

15230.2.2.5 **SHAFT PACKING** - Shaft packing shall be of the self-adjusting permanent type.

15230.2.2.6 **OPERATION** - Underground opening and closing shall be accomplished with permanently lubricated screw-type operators, totally enclosed and of watertight construction. Overload protection shall be incorporated into the operator allowing the application of 450 foot-pounds input torque at full-open and full-closed positions without damage to the operator or valve. A 2-inch square wrench nut and valve box shall be provided for operating the valve. Valves shall open counter clockwise unless indicated otherwise in the Special Provisions.

15230.2.3 BALL VALVES

15230.2.3.1 **MANUFACTURER** - Valves shall be produced by a manufacturer having at least five years experience in the manufacture of water works and valves.

15230.2.3.2 **VALVES 4-INCHES AND LARGER** - Ball valves, 4-inches and larger, shall be ductile iron or cast-steel body, double seated valves meeting the requirements of ANSI/AWWA C-507.

15230.2.3.3 **SMALLER VALVES** - Smaller valves shall be stainless steel, bronze, or iron bodied valves of the size, type and class shown on the Drawings.

15230.2.4 CHECK VALVES

15230.2.4.1 **COMPLIANCE** - Check valves shall be manufactured in accordance with ANSI/AWWA C-508.

15230.2.4.2 **DESIGN** - Check valves shall be of a clear waterway, swing-check type. They shall be designed to be mounted horizontally. They shall be fitted with flanged ends for easy servicing. They shall have an iron body and be bronze mounted.

15230.2.4.3 **SEATING** - Valves shall be provided with a metal to resilient material seating.

15230.2.5 HOSE BIBS

Hose bibs shall be 3/4-inch bronze or brass body, Watts Model SC-1, Red & White Model RW 301 or approved equal. All hose bibs shall have a tee handle.

15230.2.6 SAMPLE FAUCET

Sample faucet shall be a 1/2-inch chromed or brass body hose bib without hose connection threads.

15230.2.7 FIRE HYDRANTS

15230.2.7.1 **COMPLIANCE** - Fire hydrants shall conform to standard for dry barrel fire hydrants, AWWA C-502 and modifications herein specified.

15230.2.7.2 **DESIGN** - Hydrants shall be designed as follows:

- Hydrants shall be of the "compression" or "toggle joint" type with safety flange and safety stem coupling above the ground line so that they can be repaired without shutting off the water.
- Hydrants shall be of the dry top design with two or more "O" rings sealing the water from the operating mechanism.
- Hydrants shall be furnished with 5-inch minimum valve openings, one 4 1/2-inch NST pumper connection and two 2 1/2-inch hose connections.
- Hose nozzle threads, pump nozzle threads, operating nut and opening direction shall match existing hydrants in the system.
- Hydrant lengths shall be designed for the cover depth shown on the drawings plus the diameter of the main line pipe.

15230.2.7.3 **PAINTING** - The portion of the hydrant above the ground line shall be painted in accordance with the Owner's standards.

15230.2.8 OPERATING WRENCHES

Unless notified otherwise by the Engineer, the Contractor shall furnish two, T-handle, operating wrenches for each project incorporating valves with 2-inch, square-head, operating nuts.

15230.2.9 VALVE BOXES

Valve boxes shall be cast iron, two piece, and adjustable valve boxes. Valve boxes shall be of the slip joint type and be of sufficient length for the pipe burial depth required. The cast iron cover of the valve box shall have the word "water" stamped thereon.

15230.2.10 CONCRETE ENCLOSURES

Concrete enclosures for valves shall be precast and of the type, size and configuration shown on the Drawings and shall be fabricated in accordance with the requirements for precast concrete construction provided in Section 03500.

15230.3 CONSTRUCTION REQUIREMENTS**15230.3.1 SETTING VALVES AND VALVE BOXES**

All valves shall be set and jointed to the pipe in the manner described for pipe laying and jointing in Section 02222 of these Specifications. Valves shall be oriented with the operating nut vertical. Valve boxes shall be centered and plumb over the operating nut and shall be set so that no shock or stress will be transmitted to the valve. Tops of the valve boxes shall be set flush with the ground surface, concrete collars, or street surfacing, unless otherwise shown on the Drawings.

15230.3.2 VALVE RESTRAINT

Restraint shall be installed on all valves connected with slip-on, gasketed, or O-ring joints (i.e., bell & spigot, mechanical, etc.) in accordance with these Specifications and as shown on the Drawings.

15230.3.3 CONNECTING TO EXISTING MAINS

15230.3.3.1 CONNECTION TO EXISTING WORK - All connections to existing water mains shall be made by the Contractor, unless otherwise provided in these Specifications. The Contractor shall provide labor and materials, including special fittings and restraint devices, required to make the required connections between existing lines and new lines.

15230.3.3.2 INTERRUPTION OF SERVICES - Where the connection of new work to old requires interruption of service, the Owner, Engineer and Contractor shall mutually agree upon a date for such connection which will allow ample time to assemble labor and materials and to notify all customers in accordance with Section 01510.

15230.3.4 FIRE HYDRANT INSTALLATION

15230.3.4.1 SETTING - All hydrants shall stand plumb use hand level with the pumper nozzle facing the street. The hydrant shall be set with the ground line at the location indicated by the hydrant manufacturer.

15230.3.4.2 DRAINAGE - Drainage shall be provided at the base of the hydrant by placing clean gravel under and around the base of the hydrant as shown on the Drawings.

15230.3.4.3 RESTRAINT - All hydrants shall be restrained by setting thrust blocks or mechanical restraint assemblies in accordance with the Drawings.

15230.3.4.4 AUXILIARY GATE VALVES - All fire hydrant assemblies shall include auxiliary gate valves positioned as shown on the Drawings.

15230.3.5 THRUST BLOCKS

Thrust blocks or joint restraints (Mega Lug) shall be formed to prevent coverage of the pipe joints in accordance with the details shown on the Drawings and as described in Section 03100 and 03050. All thrust blocks shall be set against undisturbed earth.

15230.4 METHOD OF MEASUREMENT**15230.4.1 VALVES**

Excavation, foundation preparation, restraint devices, valve boxes, backfill, and other miscellaneous devices, materials, or equipment required for installation shall be considered part of and included in the measurement of all valves and valve assemblies.

15230.4.1.1 NUMERICAL COUNT - When valves are installed as separate items or assemblies, the measurement shall be determined by counting the number of each size and type (including any associated valve box and concrete valve box collar) of valve installed and accepted.

15230.4.1.2 LUMP SUM - When valves are located in an enclosure, measurement shall be made as lump sum for the enclosure assembly and shall include the valve, any supplemental valves and fittings in the enclosure, and the enclosure.

15230.4.2 HYDRANTS

Measurement of hydrants shall be made by counting the number of hydrants set and accepted. For each hydrant, this measurement shall include the tee, shut-off gate valve, excavation and backfill, drain gravel, valve box and concrete collar, restraint, hydrant, and 5-feet of pipeline extending from the tee on the main line to the hydrant.

15230.4.3 NO SEPARATE MEASUREMENT

No separate measurement will be made for thrust blocks or other restraint provided with valves and fittings. Neither will separate measurement be approved for sample faucets and hose bibbs. Measurement for these items will be included with the quantity of the assembly whereon they are installed.

15230.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price.

PAY ITEM	UNIT
<i>(Size)</i> Gate Valve	Each
<i>(Size)</i> Ball Valve	Each
<i>(Size)</i> Ball Valve	Each
<i>(Size)</i> Butterfly Valve	Each
<i>(Size)</i> Check Valve	Each
Fire Hydrant Assembly	Each

15232.1 DESCRIPTION

This section covers furnishing and installing water system control valves, including: pressure release, pressure sustaining, pressure reducing, water level control, air relief, vacuum relief, deep well pump control, back flow prevention and surge control with their enclosures and miscellaneous support equipment.

15232.1.1 RELATED WORK

Section 02222 - Waterline Pipe Installation
Section 03050 - Portland Cement Concrete
Section 03100 - Concrete Forming, Finishing and Curing
Section 03200 - Concrete Reinforcement
Section 15110 - Pipe and Piping Systems
Section 15230 - Waterline Valves and Hydrants

15232.1.2 SUBMITTALS

15232.1.2.1 CERTIFICATION OF COMPLIANCE - Certification of compliance to the standards and Specifications contained herein shall be obtained from the manufacturer and provided by the Contractor at the time of delivery of these materials to the project site.

15232.1.2.2 DESCRIPTIVE LITERATURE - Descriptive literature which identifies the manufacturer, model numbers, materials of which the control valves are fabricated, and their capacities shall be provided by the Contractor in accordance with Section 01300 of these Contract Documents.

15232.1.2.3 OPERATION AND MAINTENANCE INSTRUCTIONS - Manufacturer's installation, operation and maintenance literature for each control valve shall be furnished to the Owner prior to the time of final acceptance for payment.

15232.1.3 DEFINITIONS

Not used.

15232.2 MATERIALS**15232.2.1 GENERAL**

All control valves furnished and installed under this contract shall be of the model, size, and type shown on the Drawings or required in these Specifications. They shall have been produced by the same manufacturer and shall be provided by a supplier located in the state in which the installation is to be made. They shall be furnished with a manufacturer applied, NSF approved, fusion bonded, epoxy coating. Seats shall be designed so that they are easily maintained and without edges that induce cutting or wear at low flows. Unless otherwise required to meet specific service conditions, all cast iron or steel valves shall be 150 lb. Class.

15232.2.2 ALTITUDE CONTROL VALVES

Altitude control valves shall be as manufactured by CLA-VAL Company, or approved equal. Valves shall be of ductile iron flanged, spring loaded, 3-way, diaphragm actuated, globe pattern valves. Valve control shall be provided by a pressure difference sensor (and when called for on the Drawings or in these Specifications, fitted with a direct acting solenoid control) with appropriately sized piping and supports. Valves shall have a valve position indicator, cocks to isolate the pilot system and closing speed control. Four-inch and smaller valves shall be fitted with flow clean strainer while larger valves shall be provided with a "Y"-pattern strainer in the pilot control system.

15232.2.3 PRESSURE RELIEF/PRESSURE SUSTAINING VALVES

Shall be ductile iron, modulating, hydraulic operated, pilot controlled, flanged valves with globe pattern. All pressure sustaining valves shall be designed to maintain constant upstream pressure at the set point indicated on the Drawings or in the Special Provisions. Pressure sustaining valves shall be provided with a position indicator operated by a pressure difference sensor and shall have appropriately sized piping and supports. The pilot system shall be capable of being isolated with shut-off cocks, be fitted with a strainer, and shall be able to control closure to prevent surges.

15232.2.4 COMBINATION BACK PRESSURE/SOLENOID SHUTOFF VALVE

Shall be ductile iron, flanged, globe pattern, modulating hydraulic operated, pilot controlled, with solenoid activated shut-off. The valve shall open sufficiently to maintain a pre-set inlet (back) pressure. When the inlet pressure is less than the control setting, the pilot system shall close the valve tight. The pilot system shall be capable of being isolated with shut-off cocks, be fitted with a strainer and shall be able to control closure to prevent surges.

15232.2.5 PRESSURE REDUCING VALVES

Shall be modulating pressure reducing with globe pattern. Valves shall be provided with pilot control which operates such that positive and gradual closure can occur to prevent any surge or line shock. Pressure reducing valves shall be equipped with a valve position indicator, cocks to isolate the pilot system, speed for control of closure and a strainer on the pilot system inlet.

15232.2.6 BACK-FLOW PREVENTION VALVES

Shall be an assembly of double independently acting, spring-loaded toggle lever check valves with two shut-off valves which meet the requirements of ANSI/AWWA C-506. Valve body and cover shall be of bronze. Valves shall be fitted with stainless steel springs and with molded synthetic rubber clapper, poppet and facing rings.

15232.2.7 AIR/VACUUM RELIEF VALVES

Shall be simple lever type, kinetic combination air valves, with cast iron body and stainless steel floats. Vents for air/vacuum relief valves shall be threaded GI pipe and shall be protected with fittings covered with No. 14 stainless steel, bronze or aluminum screen.

15232.2.8 DEEP WELL SOLENOID PUMP CONTROL VALVE

Shall be globe pattern, hydraulically operated diaphragm valve controlled by a solenoid pilot valve. The pilot system shall have separate adjustable flow control valves, a "Y" strainer, and shall be fitted with cocks to enable isolation during servicing. The valve stem shall have a limit switch to serve as an electrical interlock between the valve and pump motor.

15232.2.9 ENCLOSURES

Enclosures for control valves shall be concrete, furnished and installed in accordance with the Drawings and the requirements of Sections 03100, 03200, and 03050 of these Specifications.

15232.2.10 MISCELLANEOUS PIPE, FITTINGS, VALVES AND EQUIPMENT

Miscellaneous pipe, fittings, valves and equipment needed to assemble and support operation of the control valves shall be as shown on the Drawings and in conformance with Sections 02222, 15110, and 15230 of these Specifications.

15232.3 CONSTRUCTION REQUIREMENTS

Prior to installing control valves, the Contractor shall flush, blowout, or otherwise clean all dirt and debris from connecting lines. Control valves shall be installed with appropriate supporting piping and equipment in accordance with manufacturer's recommendations. Control valves shall be fitted with flanged connections or installed in a manner which will allow easy removal in the enclosure or area wherein the valves are installed. As soon as control valves are pressurized (placed in service), the Contractor shall check and adjust, if necessary, all valve assemblies to assure they are adjusted correctly and functioning as designed.

15232.4 METHOD OF MEASUREMENT

15232.4.1 NO MEASUREMENT

Measurement will not be made for control valves that are installed as part of a structure or assembly identified as a separate line item in the Bid Schedule. In such cases, valves and their installation will be included in the lump sum quantity represented for that structure.

15232.4.2 SEPARATE MEASUREMENT

When valves are identified as individual line items on the Bid Schedule, quantities shall be measured by counting the numbers of each type of valve in place and accepted. In such cases, measurement will include all valves, couplings, enclosures, manhole covers, excavating and footings required and other necessary equipment and materials required to complete the assembly as shown on the Drawings.

15232.5 BASIS OF PAYMENT

The accepted quantity will be paid for at the contract unit price:

PAY ITEM	UNIT
Altitude Valve (size, type)	Each
Float Valve (size, type)	Each
Pressure Relief Valve (size, type)	Each
Pressure Sustaining Valve (size, type)	Each
Pressure Reducing Valve (size, type)	Each
Pressure Reducing Valve (size, type)	Each
Back Pressure Valve (size, type)	Each
Backflow Prevention Valve (size, type)	Each
Air Release Valve (size, type)	Each
Vacuum Relief Valve (size, type)	Each
Air/Vacuum Relief Valve (size, type)	Each
Combination Air/Vacuum Valve (size, type)	Each
Sewage Air Relief Valve (size, type)	Each
(Type)Valve Assembly	Each

15238.1 DESCRIPTION

Includes furnishing and installing pressure gauges and their support piping and fittings in buildings and other structures at locations shown on the Drawings.

15238.1.1 RELATED WORK

Section 02222 – Waterline Pipe Installation
Section 15110 – Pipe and Piping Systems

15238.1.2 SUBMITTALS

The Contractor shall provide descriptive information which indicates the model number, manufacturer's name, dimensions, measuring range and manufacturer's certification of performance in accordance with the requirements of Section 01300.

15238.1.3 DEFINITIONS

Not used.

15238.2 MATERIALS**15238.2.1 PRESSURE GAUGES**

Shall be US Gauge, Model 656, stem mounted and oil filled, as manufactured by AMETEK or an approved equal. Gauges have a 2 1/2-inch (minimum) stainless steel case with a pressure relief plug. The window shall be polycarbonate plastic with neoprene sealing gasket. The pressure reading range shall be as shown on the Drawings or as prescribed in the Special Provisions.

15238.2.2 SUPPORTING PIPE AND FITTINGS

Shall be 1/4-inch threaded Schedule 40 galvanized pipe.

15238.3 CONSTRUCTION REQUIREMENTS

Pressure gauges shall be installed in accordance with the manufacturer's recommendations and at the locations shown on the Drawings. The Contractor shall provide sufficient supporting pipe to mount pressure gauges vertically and oriented to be read easily. When possible, pressure gauges should be installed at least three pipe diameters downstream from any valve in the pipeline.

15238.4 METHOD OF MEASUREMENT

Separate measurement of pressure gauges and their supporting piping will not be made. Measurement will be included with the building or structure that it serves.

15238.5 BASIS OF PAYMENT

Separate payment for pressure gauges will not be made.

15236.1 DESCRIPTION

Includes furnishing and installing tubular flanged water flow meter(s) of the size and type and location shown on the Drawings and as described in these Specifications.

15236.1.1 RELATED WORK

Section 02222 - Pipe Installation

15236.1.2 SUBMITTALS

The Contractor shall provide complete information which includes cutaway drawings, parts lists, and manufacturer's installation instructions in accordance with the requirements of Section 01300.

15236.1.3 DEFINITIONS

Not used.

15236.2 MATERIALS**15236.2.1 PERFORMANCE CAPABILITY**

Flow meters shall be able to accurately operate in working pressures up to 150 PSI, at temperatures up to 140 degrees F. and for flows 40 GPM and greater. Meter sizes and measuring capacity shall be as shown on the Drawings. The meter's flow indicator shall be mechanically driven with a 3.5-inch (minimum) dial that provides a flow reading and totalizer reading up to six digits in GPM and total gallons. Meters installed in systems or at locations which are controlled by an electronic telemetry system shall be furnished with flow transmitters which can be connected into that system to indicate flow conditions.

15236.2.2 FABRICATION

Flow meters shall be manufactured to meet the requirements of ANSI/AWWA C-704 with a steel meter tube fitted with straightening vanes, all of which is coated with a fusion epoxy resin. Interior components of the meter shall be fabricated from stainless steel, plastic or other corrosion resistant materials which will provide long service. The propeller shall be magnetically connected to the drive mechanism and mounted with bearings which provide smooth operation for flows in both directions. The gearbox shall be cast bronze and the meter head shall be fabricated from cast iron or epoxy coated steel.

15236.3 CONSTRUCTION REQUIREMENTS

Flow meters shall be installed in accordance with the manufacturer's recommendations and consistent with the Drawings. The Contractor shall provide all materials and installation labor to assure proper installation and calibration of the meter(s) required.

15236.4 METHOD OF MEASUREMENT**15236.4.1 NO MEASUREMENT**

Separate measurement will not be made for flow meters when installed as a component of a building, enclosure or assembly for which measurement is indicated in the Bid Schedule.

15236.4.2 SEPARATE MEASUREMENT

Separate measurement may be made for meters furnished and installed when so identified in the Bid Schedule. Measurement shall be made by counting the number of each size and type of valve installed and accepted.

15236.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	UNIT
(<i>Size</i>) Flow Meter	Each

15300.1 DESCRIPTION

The Contractor shall furnish and install floor drains in structures of the size and type, and at the locations shown on the Drawings.

15300.1.1 RELATED WORK

Section 02222 – Waterline Pipe Installation
Section 02105 - Earthwork Materials

15300.1.2 SUBMITTALS

Not used.

15300.1.3 DEFINITIONS

Not used.

15300.2 MATERIALS**15300.2.1 DRAIN**

Floor Drains shall be cast iron body, 6-inch (minimum) diameter heavy-duty grated type with a removable cast iron or stainless steel cover.

15300.2.2 PIPING

Drain piping shall be drain waste and vent (DWV) schedule 40 PVC pipe and fittings sized to fit the floor drain in accordance with the Drawings.

15300.2.3 P-TRAPS

P-traps, when required on the Drawings, shall meet the requirements of Schedule 40 PVC pipefittings sized to fit the drainpipe.

15300.2.4 DRAIN GRAVEL

Drain gravel for floor drain sumps, where applicable, shall meet requirements of Section 02105 and shall be installed as shown on the Drawings.

15300.2.5 CHECK VALVES

Floor drain check valve, when required by the Drawings, shall be a rubber slip-on check valve capable of draining drainpipe under low flows and low pressures. The valves shall require no maintenance or repair. The check valves shall be attached to the drainpipe by stainless steel clamps.

15300.3 CONSTRUCTION REQUIREMENTS**15300.3.1 SETTING DRAINS**

Where floor drains are required, the floor will have been designed with a slope to a low point where the drain is to be placed. Typically, the floor drain will be cast in the low point in the floor at the time of installation of the floor. The Contractor shall take care to coordinate the setting of

the drain and the pouring of the concrete so that the top surface of the drain cover is flush with the floor surface to allow complete drainage of any water which accumulates on the floor.

15300.3.2 **PIPE WORK**

Piping shall be connected and run on a 1% minimum slope away from the drain as shown on the Drawings. Where termination of the piping is in drain gravel, care shall be taken to locate the pipe end in the top one-third of the gravel sump. Where termination of the piping is at daylight, the Contractor shall provide a 5-foot section of cast iron or ductile iron pipe, sized to match the drain pipe, at the daylight end of the pipeline so that the thermoplastic pipe will not be exposed to daylight.

15300.4 METHOD OF MEASUREMENT

15300.4.1 **NO MEASUREMENT**

Unless provided for as a separate bid item in the Bid Schedule, no separate measurement of the floor drain, its connecting piping, gravel sump, etc., will be made. Measurement of the drain will be included with the building or structure identified in the Bid Schedule.

15300.4.2 **SEPARATE MEASUREMENT**

When provided for in the Bid Schedule, the cost of all material and labor required of the floor drain assembly will be measured by counting the number of floor drain assemblies installed and accepted.

15300.5 BASIS OF PAYMENT

When a separate bid item is provided, complete compensation for this accepted work shall be included in the contract unit price on the Bid Schedule.

PAY ITEM	UNIT
Floor Drain Assembly	Lump Sum
Floor Drain Assembly	Each

DIVISION 16

ELECTRICAL

16010.1 DESCRIPTION

The General Conditions, Supplementary General Conditions, Alternates and Addenda, applicable drawings and the Technical Specifications herein shall apply to the providing and construction of a complete electrical system under the requirements of this Division 16.

16010.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 01300 - Submittal Procedure
Section 02200 - Backfilling Trenches
Section 16150 - Electrical Control Devices
Section 16400 - Service and Distribution System

16010.1.2 SCOPE

- A. The Work required under this Section consists of the Electrical General Requirements and related items necessary to complete the Work indicated within the Contract Documents.
- B. This Section describes procedures and incidental items of Work relating to Electrical Division 16.
- C. The drawings are diagrammatic, intended to indicate the general scope and location of the Work to be installed and are not to be considered as complete in every detail. The Contractor shall install all Work indicated and/or specified herein, complete in every way to perform the function (s) intended without additional cost.
- D. Plans and Specifications are complementary; whatever is called for in either shall be as called for in both. In the event Work is called for in more than one place and is of conflicting requirements, the right shall be reserved to require the installation of the larger or the more expensive.

16010.1.3 CONTRACT DOCUMENTS

- A. Contract documents consist of drawings, specifications, and other documents issued by the Engineer. Each is complementary and requirements shown, written or reasonably inferable therefrom on one is considered as written, shown and implied in all.
- B. Electrical drawings are diagrammatic but shall be followed as closely as actual construction and Work of other Contractors will permit. Runs to panels from outlets referred to as "home runs" are indicated, by pointing in the general direction of panels. Contractor shall continue such circuits to the panels as though the routes were completely indicated.
- C. Deviations from the Drawings required to make Work of this Contract conform to Building as constructed, or as to Work of other contractors or subcontractors, shall be made by the Contractor at his expense. The Engineer reserves the right to make minor changes in the location of equipment and outlets without additional charges.
- D. The Contractor shall familiarize himself with the architectural and mechanical plans. The Contractor shall perform all Work and provide all material required by the electrical Contractor shown under these and all other sections of the plans and specifications.

16010.1.4 SUBMITTALS

All submittals shall meet the requirements of Section 01300 of these Specifications.

16010.1.4.1 SHOP DRAWINGS – Submittal of shop drawings shall be as follows:

- A. Submittal of shop drawings shall meet the requirements of Section 01300 of these Specifications.
- B. Shop drawings shall be submitted within fifteen (15) days after the award of contract.
- C. Shop drawing shall include functional and descriptive literature of the particular item furnished complete with dimensional drawings, rough-in and installation instructions, knock-out locations, hangers or mounting devices, etc., as required for the proper checking and installation of the equipment. Catalog sheets without any reference made to the particular item will not be acceptable. All special features called for in the Contract Documents shall be noted. Where performance test results of a product design are called for in the technical sections of these specifications, test data sheets shall be provided with the shop drawing submittal.
- D. Shop drawings shall be submitted for all switch gear, motor control centers, motor starters, control panels, telemonitoring panels, alarms, electrical controls, electrical instrumentation, communication devices and circuitry, lighting fixtures, and equipment anchors and supports for seismically supported components.
- E. In connection with seismic restraint requirements, shop drawings are required for all equipment anchors, supports, and seismic restraints. Submittals shall include weights, dimensions, load/deflection data, centers of gravity, standard connections, manufacturer's recommendations, and behavior problems (vibration, thermal, expansion, etc.) associated with equipment so that the final design can be properly reviewed.
- F. Three preliminary sets shall be submitted to the Architect/Engineer for their review. Following review, two sets will be returned to the Contractor for correction. After corrections have been made, the formal six sets of the corrected shop drawings shall be submitted for final review and distribution.
- G. Each shop drawing required under this or other sections of Division 16 shall be bound together in sets in one hard back three ring binder per set, properly indexed for the formal submittal. Binders shall be properly sized to adequately contain all of the materials to be placed therein and shall be labeled to identify the Owner, the name of the job, the name of the Contractor and/or any sub-contractor (s), and any other pertinent information.

16010.1.4.2 MATERIALS LIST - A materials list including manufacturer, type, size, model number and other properties shall be submitted for all raceway, conduit, fittings, support materials, wire, cable, junction boxes, and wiring devices, including boxes for weather proof devices.

16010.1.4.3 EQUIPMENT/INSTRUMENT LIST - Equipment/Instrument list(s) including manufacturer, type, size, model number and other properties shall be submitted for all equipment and instruments.

16010.1.4.4 OPERATION AND MAINTENANCE MANUAL – The Contractor, or electrical subcontractor, shall assemble and deliver to the Owner an operation and maintenance (O&M) manual for the electrical systems furnished and installed in connection with the Work. O&M manuals shall be as follows:

- A. Number of copies shall be as specified in Section 01300 or as required in the Special

Provisions or by the Engineer or the Owner. The O&M manual shall be reviewed and approved prior to the final inspection.

- B. Each copy of the O&M manual shall be bound in a hard-backed binder. The front of each binder shall have the following information printed on it by silk screen process:

OPERATION AND MAINTENANCE MANUAL
FOR
(PROJECT NAME)
(SPECIFIC SYSTEM NAME AND/OR LOCATION, as appropriate)
(OWNER'S NAME)

- C. Each copy shall contain a master index at the beginning of the manual showing all items included.
- D. A separate section for each different type of item of equipment or information furnished shall be provided. Use plastic tab indexes for all sections of the book.
- E. The first section of the manual shall consist of the names, addresses and telephone numbers of the Mechanical Engineer, Electrical Engineer, General Contractor, Electrical Contractor.
- F. Descriptive literature (manufacturer's catalog cuts and other data) of each manufactured item shall be included. Literature shall show capacities and size of equipment used and shall be marked indicating each specific item with all applicable data underlined.
- G. Operating instructions shall, at a minimum, include:
1. General description of the electrical system.
 2. Where applicable, a step-by-step procedure to follow in putting each piece of electrical equipment in operation.
 3. Provide diagram for the electrical control system showing the wiring of all related electrical control items, such as fuses, interlocks, electrical switches and relays.
 4. Test results of all items requiring testing as called for in the technical section of specifications.
- H. Maintenance instructions shall, at a minimum, include:
1. Manufacturer's maintenance instructions for each piece of electrical equipment installed in the project. Instructions should include installation instructions, parts numbers and lists, operation instructions of equipment, name of vendor, and maintenance and lubrication instructions.
 2. A summary list of each piece of electrical equipment requiring lubrication, showing the name of the equipment, location, type and frequency of lubrication.
 3. A complete list of all electrical equipment used indicating name, model, serial number and nameplate data of each item, together with number and name of each system with which the item is associated.
- I. An approved copy of the manual shall be used during final inspection and shall be left with the Owner for its use and disposition.

16010.1.4.5 OTHER INFORMATION - Other information shall be provided as required by the Engineer.
16010.2 MATERIALS

All equipment and materials shall be as specified, new, of the best quality and free from defects. Each type of equipment or material shall be the same make and quality.

16010.2.1 UNDERWRITERS LABORATORIES

All equipment, materials, and devices shall be approved by Underwriters Laboratories, Inc. (UL). Custom designed items shall be fabricated using UL approved materials. All custom panels shall bear the UL label certifying UL-508 standards.

16010.2.2 MATERIALS AND EQUIPMENT TO BE SUPPLIED

The Contractor or electrical Subcontractor shall provide all materials, equipment, and any other fittings or devices required for a complete and finished installation. Materials and equipment shall be as shown on the Drawings and/or as called for in these Specifications, including the Special Provisions if any, unless otherwise approved, in writing, by the Engineer.

16010.2.3 APPROVAL OF SUBSTITUTIONS

Equipment and materials are designated by one or more manufacturer's name brands or numbers. It is not the intent of the Specifications to exclude other equipment or materials that equal the standard of those specified. If the Bidder, in its bid, desires to use equipment or materials other than those specified, the Bidder must obtain written approval from the Engineer in this regard at least seven (7) calendar days prior to bidding. Submit complete data, including detailed specifications and drawings with written request in duplicate. Samples may be requested if deemed necessary. Certificates of compliance with specifications or a list of all exceptions to the specifications shall be included with request.

16010.2.4 STORAGE OF EQUIPMENT AND MATERIALS

- A. The Contractor shall be responsible for the proper transportation, unloading, storage, and holding of all electrical systems, materials, and equipment until they are installed in the Work, and accepted by the Owner. This shall include responsibility for damage, loss, theft, and pilferage.
- B. Materials and equipment shall be handled and stored in accordance with the manufacturer's and/or supplier's instructions. Packaged items shall be stored in original, undamaged condition with manufacturer's seals and labels intact. Materials and equipment shall be stored in a neat and orderly condition at all times and allowing for easy access for inspection.

16010.2.5 RACEWAYS AND FITTINGS

The manufacturer shall be Republic Steel, Triangle, National, Carlon, Allied or approved equal. All conduits shall be in accordance with the requirements of the National Electric Code (NEC) and applicable local codes. Steel conduit shall be in accordance with recommendations of the latest edition of American Iron and Steel Institute "Design Manual on Steel Electric Raceways."

A. RIGID GALVANIZED STEEL CONDUIT (RGS)

- 1. Shall be USAS C80.1, zinc-coated by hot-dip galvanizing or sheradizing with additional enamel or lacquer coating.
- 2. Fittings shall be threaded type and of the same material as the conduit.
- 3. Unless otherwise noted, rigid metallic conduit shall be used for underground runs, under slab runs, and where runs are placed in concrete. It shall also be used

- for exposed runs in mechanical rooms and for other exposed runs where the conduit is exposed to moisture, weather or mechanical injury.
4. Where rigid metallic conduit is used for underground installations, including elbows required to make sweeps in PVC conduit runs, the conduit shall be wrapped with 3m-50 10 mil pipe wrap or approved equal.
- B. INTERMEDIATE METAL CONDUIT (IMC)
1. Shall be UL Standard 1242, hot-dip galvanized steel.
 2. Fittings shall be threaded type and of the same material as the conduit.
 3. It can be used for exposed runs in mechanical rooms and for other exposed runs where the conduit is exposed to moisture, weather or mechanical injury.
 4. **This conduit shall not be used in hazardous areas.**
- C. ELECTRICAL METALLIC TUBING (EMT)
1. Shall be in accordance with UL “Standard for Electrical Metallic Tubing” No. 797, galvanized mild steel with interior coat of enamel.
 2. Fittings shall be steel compression type.
 3. **Cast type, indenter, or set-screw type fittings shall not be used.**
 4. EMT shall ONLY be used for exposed and concealed runs to lighting fixtures above 10 feet, unless otherwise specified, or above ceilings.
 5. **This conduit shall not be used in hazardous areas.**
- D. NON-METALLIC CONDUIT (PVC)
1. Shall be PVC Schedule 40 heavy wall suitable for direct burial.
 2. Fittings shall be threaded or solvent welded type of the same material as the conduit.
 3. **Shall not be used above grade or embedded in concrete, except as noted specified for runs above 600 volts. PVC shall not be used where exposed or concealed in walls or floors.**
 4. PVC may be used for all underground runs, except for bends exceeding 22 degrees where jacketed or wrapped rigid galvanized steel is required, and runs under concrete slabs. Runs under concrete slabs shall be embedded in earth a minimum of 4 inches below the bottom of the slab. Risers through concrete slabs shall be rigid steel or intermediate metal conduit.
 5. Provide PVC to steel adapters as required.
- E. FLEXIBLE LIQUID-TIGHT CONDUIT
1. Shall be galvanized steel, liquid-tight, with moisture and oil- proof extruded PVC cover.
 2. Fittings shall be liquid-tight, compression type.
 3. Approved for flexible connections to equipment, items or instruments subject to vibration such as motors, fans, pumps, dry transformers, etc.
 4. **Flexible Liquid-tight conduit shall not be less than 18 inches in length and not more than 3 feet in length.**

F. FLEXIBLE STEEL CONDUIT

1. Shall be galvanized steel.
2. Fittings shall be compression type of the same material as the conduit.
3. Shall be used for lighting fixture runs above drop ceiling grid systems or other devices required or approved by NEC or as requested or approved by the Engineer. (Install ground conductor per NEC in runs over 6 feet in length.)

G. PVC COATED CONDUIT

1. Rigid Steel conduit coated with a minimum of 40 mil of PVC coating shall be used in all corrosive areas or where required by NEC or the Engineer.
2. **All fittings, boxes, support materials, clamps, etc., used with PVC coated conduit shall be PVC coated in a like manner.**
3. Wiring devices shall be corrosion resistant UL rated in corrosive areas requiring PVC coated conduit.

H. WALL AND FLOOR SLEEVES

Shall be galvanized sheet steel or pipe.

I. CLAMPS

1. Shall be galvanized malleable iron one-hole straps, beam clamps or other approved device with necessary bolts and expansion shields.
2. **Perforated metal straps shall not be used.**

J. CONDUIT SIZES

1. Shall be as indicated on the drawings.
2. **Shall not be smaller than 3/4 inch exposed or 1 inch buried conduit unless otherwise specifically approved by the Engineer.**

K. CONDUIT BUSHINGS

1. For conduit 1-1/4 inch and larger use OZ type BLG or SBLG with Lay-in-Lug.
2. Use Lay-in-Lug bushings on multiple conduit entrances to enclosures or gutters.
3. Bonding bushings shall be used on conduits containing service entrance conductors.

L. ENTRANCE SEALS

Provide and install OZ entrance seals on all conduits entering building below grade.

M. RACKS AND SUPPORTS

1. Conduit support racks, Unistrut supports and fittings, etc., shall be hot-dipped galvanized, except in corrosive areas where the supports and fittings must be PVC coated.
2. **Painted metal supports are not allowed.**

N. PULL BOXES

1. Pull boxes, which are required for proper conduit installation, shall be sized according to the requirements of Article 314 of the NEC.
2. Conduit bodies shall be cast type with threaded hubs.
3. Outdoor, buried pull boxes shall be Oldcastle H-Series or equal.
 - a) Pull boxes shall be sized per NEC 314.28.
 - b) If fully enclosed pull boxes are used, they shall be coated with coal tar epoxy per specification 9900.3.2.4.

O. OUTLET/JUNCTION BOXES

1. Boxes shall be provided in the wiring or raceway systems wherever required for routing/pulling of wires, making connections and mounting of devices or fixtures.
2. Boxes in exposed conduit runs shall be cast metal condulets with threaded hubs installed exposed. **Non-metallic boxes are not allowed.**
3. Each box shall be metal and shall have the volume required by the National Electrical Code for the number of conductors enclosed in the box. Boxes for mounting lighting fixtures shall not be less than 4 inch octagonal or 4 inch square except that smaller boxes may be installed as required by fixture configuration, as approved. Boxes in the raceway system shall not be less than 1-1/2 inches deep, except where shallower boxes required by structural conditions are approved.
4. Boxes for other than lighting fixture outlets shall not be less than 4 inches square.
5. Boxes in concealed conduit runs shall be equipped with tile extension rings, device mounting straps and accessories required for the purpose of the outlet.

16010.2.6

A. CONDUCTORS

1. Shall be of the type, size, and locations as shown on the Drawings and meet the requirements of the latest addition of the National Electric Code (NEC).
2. Shall be soft-annealed coated copper in accordance with ASTM B33 or B189.
3. Conductors No. 10 and smaller shall be solid copper for lighting circuits only, all other circuits shall be stranded copper.
4. All conductors shall be THHN/THWN copper rated at 600 volts, unless otherwise noted.
5. **Aluminum conductors will not be allowed.**

B. GROUNDING CABLE

Shall be as called out on the drawings and per NEC. (Grounding lugs shall be the clamp type made of high conductivity copper alloy and shall be provided for all equipment to be grounded.)

C. VFD CABLE

Conductor size shall be as shown in Plans and shall meet the requirements of the latest addition of the National Electric Code (NEC). Cable shall meet the requirements below:

6. Cable shall be designed for VFD applications and shall be rated 600V/2kV, NEC Type TC with a 90°C rating.
7. Three Copper circuit conductors with XLPE insulation.
8. Three symmetrical copper ground wires.

9. Spiral copper tape shield with 100% coverage.
10. Outer PVC jacket.
11. Suitable for Indoor, Outdoor, Burial and Oil Resistance

Acceptable manufacturers:

1. Belden
2. Southwire
3. Approved Equal

16010.2.7 SPLICES, TAPS AND TERMINATIONS

- A. Splices, taps and terminations made in interior damp or wet locations, corrosive atmosphere locations or exterior boxes above or below grade shall be covered with 3M heat shrinkable ITCSN series sleeves or end caps or Raychem equal as approved by the Engineer.
- B. All splices shall require approval by the Engineer.

16010.2.8 SAFETY SWITCH DISCONNECTS

- A. Provide disconnect switches where shown and required by NEC as specified herein.
- B. Type: Heavy duty, manual, single throw, fusible or non-fusible as indicated.
- C. Rating: 600 volt, ampere size as noted or as required for load served.
- D. Enclosure: Nema 4, Gasketed stainless steel or as called out in equipment schedule on drawings. Stainless steel 316 shall be used in hazardous/corrosive areas. Stainless steel 304 shall be used in all other locations.
- E. Fuses: Switches shall be equipped with Type "R" fuse clips factory installed. Fuses shall be dual element type RK5 of size as noted.
- F. Non-Fusible Switches: For equipment 2 horsepower and smaller, shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment larger than 2 horsepower, switches shall be the same as fusible type.

16010.2.9 JUNCTION BOXES

- A. Junction or pull boxes, which are required but not shown, shall be sized according to requirement of Articles 370 and 373 of NEC.
- B. Shall be cast type condulets with threaded hubs.

16010.2.10 WIRE DEVICES

- A. Switches: 20 ampere, 120/277 volt, toggle type. Single pole used as designation for entire series - double pole, 3-way, 4-way or lock type. Hubbell #1221, Bryant #1221, Leviton #1221. Switch and pilot shall be Hubbell #1221-PL or Leviton #1221-PL. Double pole toggle switch shall be Hubbell #1222-2.
- B. Ground Fault Interrupter Receptacles: 20 ampere, 125 volt, NEMA 5-20R, gray color. Leviton #6398.

- C. Receptacles: 20 ampere, 125 volt, NEMA 5-20R, gray color for locations where indicated. Hubbell #5352, Bryant #5352, or Leviton #5352.
- D. All devices shall be gray in color.
- E. Special receptacles other than those listed above shall be as designated on the drawings.
- F. Device Plates:
 - 1. For surface mounted boxes plates shall be stainless steel suitable for use on cast metal device boxes, conduit FS and FD types. Shall be complete with gaskets and approved for wet locations.
 - 2. For flush boxes in finished areas, plates shall be stainless steel. Gang plates shall be one-piece.

16010.3 CONSTRUCTION REQUIREMENTS

Unless notified otherwise, the Contractor responsible for the electrical Work shall perform all electrical work in accordance with the Drawings and with these Specifications.

16010.3.1 CODES, PERMITS, LICENSES AND STANDARDS

- A. PERMITS AND LICENSES – The Contractor shall secure all permits and licenses required in connection with this work.
- B. CODES AND STANDARDS - All work, labor, and equipment shall conform to applicable State and Local Codes and Standards and the applicable sections of the latest revisions of the following:
 - American Society for Testing and Materials (ASTM)
 - National Fire Protection Association, National Electrical Code (NEC)
 - Insulated Power Cable Engineers Association (IPCEA)
 - Underwriters Laboratories Inc. (UL)
 - American Steel and Iron Institute, “Design Manual on Steel Electrical Raceways”
 - National Electrical Manufacturer’s Association (NEMA)
 - American National Standards Institute (ANSI)
 - Institute of Electrical and Electronic Engineers (IEEE)
 - Uniform Building Code (UBC)
 - Uniform Fire Code (UFC)
 - Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

Conflicts between any of the above referenced codes and standards and between any of them and these Specifications and/or the Project Drawings shall be resolved by complying with the more stringent requirements.

16010.3.2 SAFETY

- A. REGULATIONS - The Contractor’s work shall conform to the Associated General Contractors of America, Inc. *Manual of Accident Prevention in Construction* and shall comply with all current regulations of the Occupational Safety and Health Act (OSHA) as required for work identified on the Drawings or in these Specifications.

- B. SAFETY GUARDS - All equipment, which the Contractor furnishes and installs, shall be provided with appropriate safety guards for prevention of accidents. The Contractor shall provide and maintain any other necessary construction required to secure safety of life or property, including the maintenance of sufficient lights to secure such protection.

16010.3.3 DIAGRAMMATIC DRAWINGS

- A. The electrical drawings are diagrammatic, intended to indicate the general scope and locations of the work to be installed and are not to be considered as complete in every detail. The Contractor shall install all work indicated and/or specified herein, complete to perform the function intended without additional cost.
- B. The electrical drawings are diagrammatic, however, they shall be followed as closely as actual construction and work of other contractors will permit. Runs to panels from outlets, referred to as "home runs", are indicated on the drawings by arrows pointing in the general direction of panels. Contractor shall continue such circuits to the panels as though the routes were completely indicated. Deviations from drawings required to make the work of this Contract conform to building as constructed, or as to work of other contractors, shall be made at the Contractor's expense. The Engineer reserves the right to make minor changes in the location of equipment and outlets without additional charges.

16010.3.4 SITE EXAMINATION

Examination of the site shall be made by the Contractor, who shall compare it with the drawings and specifications and satisfy himself as to the conditions under which the work is to be performed. The Contractor shall, at such time, ascertain and check all conditions which may affect its work. No allowance shall subsequently be made in the Contractor's behalf for any extra expenses to which the Contractor may be put due to failure or neglect on its part to make such examination and determination of the condition.

16010.3.5 SUPERVISION

- A. A competent foreman or superintendent, approved by the Owner's Representative, shall be at the site at all times to receive instructions and shall have the proper authority to act on behalf of the Contractor. The Contractor shall verify dimensions given on the electrical drawings and report any errors or inconsistencies to the Engineer before commencing the work. The Engineer or its representative will interpret the meaning of the Drawings and Specifications where questions arise.
- B. Contractor shall assign persons to be in direct charge of work who are thoroughly experienced in the types of construction work specified herein. All labor shall be performed in a workmanlike manner by skilled workmen under the supervision of competent foremen.

16010.3.6 WORKMANSHIP

Workmanship shall be in accordance with the best present-day construction methods and shall be neat and orderly throughout the project.

16010.3.7 COORDINATION OF CONSTRUCTION

- A. The Contractor shall coordinate work with other contractors, subcontractors, the Owner, and the Engineer to assure orderly and expeditious progress of work. The Contractor shall select order/sequence of work and establish schedule of working hours for construction, all subject to review and direction by the Owner.

- B. This Contractor shall be held solely responsible for the proper installation of its work. The Contractor shall arrange with the proper contractors for the installation of anchors and other embedded devices, and for the leaving of required chases, openings, etc., and shall do all cutting and patching made necessary by its failure or neglect to make such arrangements with others. Any cutting or patching done by this Contractor shall be subject to the directions of the Engineer and shall not be started until approval has been obtained.
- C. All cutting, welding or drilling of concrete or structural members shall be properly reinforced and patched to match as nearly as possible the surrounding work. Before cutting, welding or drilling any concrete or structural member, the Contractor shall secure the approval of the Engineer. Where deemed appropriate by the Engineer, in the case of gross negligence pertaining to this issue, the Engineer reserves the right to back-charge the Contractor for the Engineers associated costs.

16010.3.8 INSTALLATION**RACEWAY AND FITTINGS****A. STANDARDS**

1. All conduit to be installed in accordance with the requirements of the National Electrical Code, latest addition.
2. Steel conduit to be installed in accordance with recommendations of American Iron and Steel Institute "Design Manual on Steel Electrical Raceways", latest addition.
3. PVC coated conduit installed in accordance with manufacturer instructions.

B. ELECTRICAL CONTINUITY

All metallic conduit systems shall be electrically continuous throughout.

C. MOISTURE

1. All conduit raceway systems shall be essentially moisture tight.
2. Conduit drainage shall be accomplished by sloping conduits towards manholes or boxes.
3. Where pockets cannot be avoided in exposed conduits, provide drainage fittings or weep holes. Weep holes drilled through the walls of any conduit or fitting shall not produce burrs on the inside or outside surface.

D. ALIGNMENT OF EXPOSED CONDUIT

Install conduit runs parallel or at right angles to lines of structure.

E. FIELD CUTS AND THREADS

1. Field cuts shall be made square, threads clean and sharp.
2. Remove burrs, sharp or rough edges by reaming.
3. Before couplings or fittings are attached, apply a coat of red lead or zinc chromate to male threads of RGS or IMC conduit, also apply these coatings or other special compound recommended by the manufacturer of the conduit where the conduit protective coating is damaged.

4. PVC coated conduit system requires male threads on conduit, elbows and nipples and all female threads on fittings or conduit couplings to be protected by application of a urethane coating.
5. **Care must be taken to assure that concrete surfaces are protected from cutting oil, any/all damage will be the responsibility of the Contractor.**

F. BENDS

1. Uniform, whether job-fabricated or made with standard fittings or boxes.
2. Do not dent or flatten conduit
3. Conduit installation should be installed symmetrically insofar as practicable.
4. Unless approved otherwise, bends larger than 1-1/4 inch shall be factory made.
5. Bends in exposed conduit shall be symmetrical insofar as practicable.
6. Do not expose bends at floor or ceiling.

G. LOCATION

1. Conduit routing is generally shown in schematic fashion, unless dimensioned or noted to the contrary.
2. Contractor is responsible to route conduits as required to connect equipment or devices.
3. Vertical risers, equipment and device locations are approximately as indicated on the drawings. Contractor shall coordinate installation of conduit with structure and equipment.
4. Contractor is responsible to coordinate conduit installation with other contractors installations, in the event of conflict, field routed conduit shall be moved at the Contractors expense.
5. Conduit shall be located a minimum 6 inches away from steam, hot water, or other hot surface. Protect from heat, as Engineer approved, if the 6 inch separation is impracticable.
6. Diagonal installation is not permitted.

H. BURIED/EMBEDDED CONDUIT

1. RGS conduit installed underground, or used in PVC runs for sweeps larger than 22 degrees, must be wrapped with 3M-50 10 mil pipe wrap, approved asphalt compound or approved equal.
2. Mid-run weep holes and gravel drainage pockets will not be permitted.
3. Conduits embedded in concrete or masonry shall be securely held in place during concrete placement and construction operations.
4. In concrete floors, conduit shall be set before pouring of concrete begins. Conduit shall be routed in a direct line, with bends as long as possible, with 2 inches minimum from conduit to bottom of slab and maximum conduit size of 2 inch, unless otherwise approved.
5. Non-metallic conduits above 600 Volts shall be encased in red concrete covered by a minimum of 2 inches on all sides.
6. Buried conduit shall be placed 18" below grade, then filled to grade with flowable fill concrete.
7. If minimum of 18" cannot be reached, 3000 psi concrete shall fill the trench to grade .

I. WALL PENETRATIONS

1. Penetrations through exterior building walls to be by core drilling and providing appropriate conduit entrance seals.

2. Openings through existing partitions shall be provided at Contractor's expense. Holes through masonry construction shall be drilled with suitable core drilling machine.
3. All work is to be performed neatly.
4. Patches shall match original material in composition and appearance.
5. Provide fire seals as detailed or required by NEC where a fire rated wall or partition is penetrated.
6. A template shall be provided by the Contractor to hold conduit groups terminating together or passing through fire walls or floors.
7. In walls and partitions, conduit shall be installed vertically. If vertical installation is impracticable, the Engineer shall approve horizontal installation for each location.

J. EXPANSION FITTINGS

Install expansion fittings in all conduit runs crossing structural expansion joints and in all straight conduit runs exceeding 75 feet in length.

K. CONDUIT ENDS

1. Insulating bushings shall be installed at open conduit ends, terminating in panels, control centers, consoles or other similar locations.
2. Plug space around cables with oakum and/or an approved sealing compound where conduits enter switchboards, cabinets or similar locations.
3. Cap or plug all spare conduit ends to prevent the entrance of foreign material.

L. CONDUIT CONNECTIONS

1. At cabinets and boxes use double locknuts and insulating bushings for rigid conduit.
2. At cable tray securely clamp conduit to tray and install insulating bushings.
3. Install insulated grounding bushings with lay-in ground lugs where metallic conduit terminates in non-metallic manholes or pullboxes.
4. Flexible conduit for connection to movable/vibrating equipment shall be liquid-tight, Sealite as manufactured by Anaconda Metal Hose Company, or approved equal, utilizing approved liquid-tight fittings.

M. SUPPORTS

1. Hangers and supports shall be galvanized or PVC coated.
2. Hangars generally are not detailed, but must be adequate to support combined weight of conduit. Rigid fastenings are to spaced at a maximum of 6 feet.
3. Clamps will be galvanized malleable iron one-hole straps, beam clamps or other approved device with necessary bolts, washers and expansion shields.
4. **Perforated metal straps shall not be used.**
5. Adjustable hangers shall be used to support horizontal runs only, use trapeze hangers for parallel runs of conduit. Install u-bolts or other approved clamping device at each end and at each elbow. Install clamp every third intermediate hanger for each conduit.

N. CONDUIT CLEANING

Contractor is to clean and swab the inside of conduits, by mechanical means, to remove foreign materials and moisture before conductors are installed.

O. SPARE CONDUITS

1. Spare conduits shall have a nylon pulling line installed for future installation of cables.
2. Recessed panels shall have three 1 inch spare conduits in the wall space stubbed-out above ceiling and three 1 inch spare conduits stubbed under the floor.
3. Spare conduits shall be capped.

CONDUCTOR INSTALLATION**A. BENDING RADII**

Not to be less than permitted by ICEA and/or NEC.

B. SUPPORTS IN VERTICAL RUNS

To be in accordance with NEC requirements.

C. SPLICING

1. Will be permitted only with Engineers approval, and will be held to an absolute minimum.
2. Permitted only in junction boxes or similar accessible locations.
3. Cover with heat shrinkable sleeves to make moisture proof and corrosive resistant.
4. No splicing of instrument or control wiring shall be allowed without specific approval, by the Engineer.

D. CONNECTORS

1. Solderless compression or mechanical type will be utilized where screw does not bear directly on the wire.
2. Apparatus lugs, conductor, and coat shall be thoroughly cleaned with suitable oxidation inhibiting compound prior to connection.
3. Retaining cup washers shall be used where solid wire is used at terminal blocks.
4. Compression type connectors shall be installed using ratchet type crimping tools that will not release until full compression has been achieved.
5. Dies for the crimping tools shall be matched to the connector and approved for use by the Engineer and the connector manufacturer.
6. Twist on type, Scotch-lok or approved equal, connectors shall be restricted to the connection of lighting fixture wires only.

E. POWER CABLES

All power cables will be installed in strict accordance with the manufacturers instruction, and in conformance with NEC.

F. CONNECTIONS

All apparatus lugs shall be tandem single or multi-barrel lugs as detailed/required.

G. CONDUCTOR PULLING

1. Use pulling grips or eyes.

2. Firmly mount pulling reels on portable stand and secure against displacement
3. Use an approved by the Engineer commercial pulling compound for lubrication.
4. Monitor and do not exceed cable-pulling tension as specified by the cable manufacturer.

H. COLOR CODING

1. Single phase service - use white for neutral conductor, and black for ungrounded conductors.
2. Three phase service - feeder and branch conductors shall be color coded as follows:

	<u>120/208 Volt</u>	<u>277/480 Volt</u>
a.	Phase A – Black	Brown
b.	Phase B – Red	Orange
c.	Phase C – Blue	Yellow
d.	Neutral – White	Grey
e.	Ground – Green or Bare	Green or Bare

3. Coding shall be by insulation color or minimum 1 inch band of colored tape.
4. Green covering of conductors shall be solely for grounding.

I. PHASING

1. Where common neutral is run for two or three circuits, phase conductors shall be connected to breakers in the panel, which are connected to different phase legs.
2. Home runs may be combined at the option of the Contractor, providing not more than three circuits are installed in one conduit, unless otherwise approved by the Engineer.

J. SERVICE SYSTEMS

1. Incoming service systems shall be grounded at two points with the UFER (ground wire tied to the rebar of the footings) and to driven ground rods as indicated on the Standard Detail Drawing.
2. Jumpers shall be provided around water meters and any dielectric sections of pipe.
3. Size shall be as indicated on the Drawings and/or as required by NEC.
4. Connections shall be accessible for inspection.
5. Neutral conductor connection to grounding electrode conductor shall be at the main service enclosure only.
6. Type of equipment and details of installation shall be verified with Power Company representatives.
7. Metering equipment shall be provided as indicated on the Drawings or as required by these Specifications.

16010.3.9 INSTALLATION OF POWER AND CONTROLS TO EQUIPMENT

Contractor shall provide all power and control wiring required for the work of other trades as described on the drawings and in the specifications, except where the furnishing and installing of such wiring is specified elsewhere. Connect cord sets to Owner furnished equipment and make connections to all electric power consuming equipment whether furnished under contract or by Owner.

16010.3.10 TEMPORARY ELECTRIC SERVICE DURING CONSTRUCTION

- A. The Project Contractor is responsible for all project electrical work unless otherwise noted. The Contractor shall be aware, however, that some or all of the project electrical work may be performed by the Owner and/or an independent electrical contractor. The division of work to be performed by others may be indicated on the drawings, or may be as called for by the Engineer. But, the Contractor shall be responsible to review the Drawings and consult with the Engineer, to determine if its scope is less than one hundred percent of all project electrical work. The Contractor shall also be responsible to coordinate and schedule its work with that of the Owner or independent electrical contractor, and to leave its installations ready, with the connecting wires coiled, for the Owner or independent contractor to connect to or to terminate as necessary, thereby ensuring the most efficient completion of the project by all parties.
- B. The Contractor or electrical subcontractor doing the work shall provide temporary power, complete with metering and wiring, for lighting and power outlets for construction tools and equipment. This contractor will make arrangements with the local power company for temporary electrical service connections for construction power.
- C. No attempt shall be made herein to specify construction power requirements for equipment in detail. However, all temporary wiring shall meet NEC, Article 305, requirements. The service shall be provided with a main disconnect, and all power receptacles shall be, or be protected by, appropriately rated GFI single-pole devices.
- D. At completion of the Project, or sooner if directed, the temporary power supply shall be disconnected and removed from the construction site.
- E. During construction, if it becomes necessary to shut down power to a critical item of equipment or process, the Contractor or electrical subcontractor shall provide the necessary wiring and a portable generator or other source of electric power to keep such critical equipment or process in operation.

16010.3.11 SEISMIC RESTRAINT

- A. The appropriate Seismic Zone Classification will be provided on the Drawings or in the Special Provisions. All electrical equipment shall be securely anchored and seismically braced in accordance with the regulations contained in the most recently adopted edition of the UBC and with the SMACNA *Guidelines for Seismic Restraints of Electrical Systems* as they pertain to the Seismic Zone Classification given.
- B. Units mounted and secured directly to structures shall be provided with connectors of sufficient strength to meet the restraining criteria.
- C. All electrical equipment which is to be securely anchored (hard mounted) to the building or structure shall have supports designed to withstand lateral and vertical "G" loadings equal to or greater than UBC requirements and SMACNA guidelines for the given seismic zone.

16010.3.12 LABELING OF J-BOX COVERS

All J-Box covers shall be labeled with information showing the voltage and the circuit number in reference to each home run pulled through that J-Box and a particular run of conduit. The Contractor shall continue such circuits to the panels as though the routes were completely indicated.

16010.3.13 REPAIR OF WORK

- A. The work shall be carefully laid out in advance and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support, or anchorage of the conduit raceways or other electrical work, this work shall be carefully done. Any damage to building, piping or equipment shall be repaired by skilled mechanics of the trades involved, at no additional cost to the Owner.
- B. Penetrations within fire rated wall assemblies shall be appropriately repaired and replaced to full integrity of the designed fire resistance of the wall.

16010.3.14 TESTING

On completion of the work, the installation shall be tested free from all grounds and short circuits. Normal feeders, circuits, and service entrance conductors with wire size #2 and larger shall be tested for leakage phase-to-ground and phase-to-phase prior to energizing the electrical system. The Contractor shall submit a written report to the Engineer showing methods used and readings taken. Voltage applied for testing shall not exceed two times normal operating voltage.

16010.3.15 GUARANTEE/WARRANTY

- A. The following guarantee is a part of the specification and shall be binding on the part of the Contractor:

"The Contractor guarantees that this installation is free from defects. The Contractor agrees to replace or repair, to the satisfaction of the Owner's Representative, any part of this installation which may fail or be determined unacceptable within a period of one (1) year after final acceptance."

- B. Electrical systems and equipment shall not be considered acceptable for substantial completion until they have performed in service continuously without malfunction for at least ten (10) days.

16010.3.16 DEFECTIVE EQUIPMENT

If equipment fails to conform to the Specifications or to operate satisfactorily, the Owner will have the right to operate said equipment until defects are corrected. The Owner will have the right to operate rejected equipment until it is replaced, without cost for depreciation use or wear. The Contractor shall remove defective equipment from operation for examination, adjustment, alteration, or change only at times approved by Owner.

16010.3.17 CLEAN-UP

- A. As the work progresses, and on a daily basis, the Contractor shall remove from the premises and surrounding streets, alleys, etc., all rubbish and debris resulting from its operations and shall leave all equipment and material furnished by the Contractor absolutely clean and ready for use.
- B. In addition, the Contractor shall periodically remove all debris and waste in order to maintain safe working and operating conditions, and shall dispose of the same in an approved manner. At the completion of work, The Contractor shall remove all its rubbish, tools, scaffolds and surplus materials from and about the site, leaving its work clean and the areas ready for occupancy.

16010.3.18 AS-BUILT DRAWINGS

Blue line white prints of drawings will be furnished by the Engineer, on which the Contractor shall accurately and neatly mark, in colored pencil, all changes or deviations from the drawings as such changes are made in the work. These drawings shall be reviewed with the Engineer on a timely basis, not to exceed at least once each month. Failure to keep as-built drawings up to date shall be cause for withholding monthly or final payment.

16010.3.19 FINAL INSPECTION AND ACCEPTANCE

The Contractor shall notify the Engineer when work is considered to be complete, in full operating condition, and ready for final inspection. The Engineer, after determining that the installation is ready for final inspection, will conduct the final inspection and tests as are deemed necessary to determine that the provisions of the specifications are satisfied. The Owner will not accept work nor make final payment to the Contractor until Engineer has certified that the work of the Contractor is complete and in conformance with the specifications and guarantees.

16010.4 METHOD OF MEASUREMENT**16010.4.1 NO SEPARATE MEASUREMENT**

Separate measurement shall NOT be made for furnishing or installing electrical systems, components, materials required to be installed within the pay limits for a building or enclosure identified in the Bid schedule to be furnished by the Contractor.

16010.4.2 SEPARATE MEASUREMENT

- A. **NEW BUILDINGS** - Separate measurement shall be made for installation of electrical systems, components, and materials, required for a building or enclosure shown on the Drawings and as called for in these Specifications and identified in the Bid Schedule, when such electrical systems, components, and materials are identified and listed in the Bid Schedule.
- B. **EXISTING BUILDINGS** - Separate measurement will be made for installation of electrical systems, components, and materials, required to be installed or replaced in an existing building or enclosure, as shown on the Drawings and as called for in these Specifications, when such electrical systems, components, and materials are identified and listed in the Bid Schedule.

16010.5 BASIS OF PAYMENT

16010.5.1 No separate payment shall be made for furnishing or installing electrical systems, components, or materials required to be installed within the pay limits for a building or enclosure identified in the BID schedule to be furnished by the Contractor.

PAY ITEM	UNIT
Electrical System (<i>Indicate Building</i>)	Lump Sum
Install Electrical (<i>Describe Component</i>)	Lump Sum
Install Electrical (<i>Describe Component</i>)	Each
Install Electrical (<i>Describe material</i>)	Lump Sum
Install Electrical (<i>Describe material</i>)	Lineal Foot
Replace Electrical (<i>Describe Component</i>)	Lump Sum
Replace Electrical (<i>Describe Component</i>)	Lump Sum
Replace Electrical (<i>Describe material</i>)	Lump Sum
Replace Electrical (<i>Describe material</i>)	Lineal Foot

16050.1 GENERAL

16050.1.1 WIRING METHOD

All wiring shall be of the following method as shown on the plans and as indicated in the Single-Line Diagram and detailed on the drawings.

- A. Insulated conductors run in conduit raceways as defined in Chapter 3 of the National Electrical Code.

16050.1.2 APPLICABLE SECTIONS

The General Conditions, Supplementary General Conditions, Special Conditions, Alternates and Addenda, applicable drawings and the technical specifications herein shall apply to all work under this Division 16.

16050.1.3 SCOPE

Provide all operations, methods, labor and equipment and provide and install all materials and incidentals necessary for the completion of the work as specified herein or included on the drawings.

16050.1.4 RELATED WORK SPECIFIED ELSEWHERE

Section 16010 - Electrical General Requirements
Section 16400 - Service and Distribution
Section 16410 - Fuses
Section 16450 - Secondary Grounding
Section 16500 - Lighting

16050.2 PRODUCTS

16050.2.1 RACEWAYS AND FITTINGS

A. RIGID GALVANIZED STEEL CONDUIT

- 1) Per USAS C80.1, zinc-coated by hot-dip galvanizing or sheradizing with additional enamel or lacquer coating.
- 2) Fittings shall be threaded type of same material as conduit.
- 3) Approved Locations: May be used in all locations except where installed underground in direct contact with earth or where subject to a corrosive atmosphere as noted.

B. INTERMEDIATE METAL CONDUIT (IMC)

- 1) Per UL Standard 1242, hot-dip galvanized steel.
- 2) Fittings shall be threaded type of same material as conduit.
- 3) Approved Locations: May be used in interior locations where not buried or in direct contact with earth or where subject to corrosive atmosphere as noted.

C. FLEXIBLE LIQUID TIGHT CONDUIT

- 1) Galvanized steel liquid-tight with PVC moisture and oil-proof extruded cover.
- 2) Fittings shall be liquid tight compression type.
- 3) Approved for flexible connections to equipment subject to vibration such as motors, fan, pumps, dry transformers, etc., 36-inch maximum, 18" minimum length for each connection.

D. NON-METALLIC CONDUIT

- 1) Unplasticized polyvinyl - chloride heavy wall Schedule 40 suitable for direct burial.
- 2) Fittings shall be threaded or solvent welded type of same material as conduit.
- 3) Approved for underground direct burial except bends over 22 degrees shall be jacketed or wrapped rigid galvanized conduit. Minimum depth of bury 30".
- 4) Not approved for above grade installation or embedded in concrete slabs.
- 5) Threaded metal to plastic adapters shall be used where connected to metal conduits.
- 6) Non-metallic conduit for use in concrete encased duct banks shall be per Section 16800 of these specifications.

E. CORROSION RESISTANT CONDUIT

- 1) Galvanized rigid conduit coated with at least 40 mil of PVC coating.
- 2) Fittings and boxes shall be of same galvanized material as conduit and coated in like manner. Wiring devices shall be corrosion resistant UL rated.
- 3) Required for all installations in area with corrosive atmosphere and all underground VFD Motor circuits

F. ELECTRICAL METAL TUBING (EMT)

- 1) Not approved for any exposed conduit runs or drops.

G. FLEX METAL CONDUIT

- 1) Used for lighting fixtures, and only above drop ceiling grid systems.

H. SIZES

- 1) As indicated but not smaller than 3/4-inch unless specifically noted.

16050.2.2 CONDUCTORS (600 Volt and below)

- A. Single conductors for installation in raceways shall be as follows:**

- 1) Size, type, location shown on drawings or as required by the National Electrical Code.
- 2) Standard: ICEA S-19-81.
- 3) Material: Soft annealed coated copper per ASTM B33 or B189.
- 4) Stranding: No. 10 and Smaller: Solid. No. 8 and Larger: Class B.
- 5) Insulation and Coverings:
 - a. Thickness: Per ICEA.
 - b. Material:
 - i. For all areas No. 8 and Smaller: Type THHN-THWN single conductor power cable, moisture resistant, flame retardant thermoplastic insulation, 600 volt, 75 C copper temperature.
 - ii. No. 6 and larger: Type THHN-THWN, XHHW single conductor power cable, heat and moisture resistant, flame retardant, thermoplastic insulation, 600 volt, 75 C. copper temperature.
 - iii. All conductors shall be copper. Aluminum conductors are not approved.
- 6) Manufacturer: Republic Steel, Triangle, National, Carlon, Allied or approved.

16050.2.3 SPLICES, TAPS AND TERMINATIONS

All splices, taps and terminations made in interior damp or wet locations, corrosive atmosphere locations or exterior boxes above and below grade shall be covered with 3M heat shrinkable ITCSN series sleeves or end caps or equal of Raychem. All splices must be approved by the Engineer.

16050.2.4 SAFETY SWITCH DISCONNECTS

- A. Provide disconnect switches where shown and required by NEC as specified herein.
- B. Type: Heavy duty, manual, single throw, fusible or non-fusible as indicated.
- C. Rating: 600 volt, ampere size as noted or as required for load served.
- D. Enclosure: Nema 4, Gasketed stainless steel or as called out in equipment schedule on drawings.
- E. Fuses: Switches shall be equipped with Type "R" fuse clips factory installed. Fuses shall be dual element type RK5 of size as noted.
- F. Non-Fusible Switches: For equipment 2 horsepower and smaller, shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment larger than 2 horsepower, switches shall be the same as fusible type.

16050.2.5 JUNCTION BOXES

- A. Junction or pull boxes, which are required but not shown, shall be sized according to requirement of Articles 370 and 373 of NEC.
- B. Shall be cast type condulets with threaded hubs.

16050.2.6 WIRE DEVICES

- A. Switches: 20 ampere, 120/277 volt, toggle type. Single pole used as designation for entire series - double pole, 3-way, 4-way or lock type. Hubbell #1221, Bryant #1221, Leviton #1221. Switch and pilot shall be Hubbell #1221-PL or Leviton #1221-PL. Double pole toggle switch shall be Hubbell #1222-2.
- B. Ground Fault Interrupter Receptacles: 20 ampere, 125 volt, NEMA 5-20R, gray color. Leviton #6398.
- C. Receptacles: 20 ampere, 125 volt, NEMA 5-20R, gray color for locations where indicated. Hubbell #5352, Bryant #5352, or Leviton #5352.
- D. All devices shall be gray in color.
- E. Special receptacles other than those listed above shall be as designated on the drawings.
- F. Device Plates:
 - 1) For surface mounted boxes plates shall be stainless steel suitable for use on cast metal device boxes, conduit FS and FD types. Shall be complete with gaskets and approved for wet locations.
 - 2) For flush boxes in finished areas, plates shall be stainless steel. Gang plates shall be one-piece.

16050.2.7 OUTLET BOXES

- A. Boxes shall be provided in the wiring or raceway systems where ever required for pulling of wires, making connections, and mounting of devices or fixtures.
- B. Boxes in exposed conduit runs shall be cast metal condulets with threaded hubs installed exposed. Non-metallic boxes are not approved.
- C. Each box shall be metal and shall have the volume required by the National Electrical Code for the number of conductors enclosed in the box. Boxes for mounting lighting fixtures shall be not less than 4 inches octagonal or 4 inches square except that smaller boxes may be installed as required by fixture configuration, as approved. Boxes for use with raceway systems shall not be less than 1-1/2 inches deep except where shallower boxes required by structural conditions are approved. Boxes for other than lighting-fixture outlets shall be not less than 4 inches square. Boxes in concealed conduit runs shall be equipped with tile extension rings, device mounting straps and accessories required for the purpose of the outlet.

16050.2.8 BUSHINGS

- A. For Conduit 1-1/4" and Larger: OZ type BLG or SBLG with Lay-in-Lug. Use Lay-in-Lug bushings on multiple conduit entrances to enclosures or gutters.
- B. Bonding bushings shall be provided on service entrance conductors.

16050.2.9 ENTRANCE SEALS Provide OZ entrance seals on all conduits entering building below grade.

16050.2.10 RACKS AND SUPPORTS: Conduit support racks, unistrut supports and fittings, etc., shall be hot-dipped galvanized. Painted metal will not be allowed.

16050.3 EXECUTION

16050.3.1 RACEWAY AND FITTING INSTALLATION:

A. STANDARDS:

- 1) All Conduit: In accordance with requirement of National Electrical Code and applicable local codes.
- 2) Steel Conduit: In accordance with recommendations of American Iron and Steel Institute "Design Manual on Steel Electrical Raceways," latest edition.
- 3) PVC coated, "Plastic-Bond-Red", conduit: In accordance with instructions in Robroy Plastic-Bond installation manual.

B. ELECTRICAL CONTINUITY:

- 1) All metallic conduit systems shall be electrically continuous throughout.

C. MOISTURE:

- 1) All conduit systems shall be essentially moisture tight.

D. ALIGNMENT OF EXPOSED CONDUIT:

- 1) Parallel with or at right angles to lines of structure.

E. FIELD CUTS AND THREADS:

- 1) Cuts shall be square, threads clean and sharp. Remove by reaming burrs, sharp or rough edges. Before couplings or fittings are attached, apply one coat of red lead or zinc chromate to male threads of rigid steel conduit. Apply coat of red lead, zinc chromate or special compound recommended by manufacturer of conduit where conduit protective coating is damaged.
- 2) PVC coated conduit system: All male threads on conduit, elbows and nipples and all female threads on fitting or conduit couplings shall be protected by application of a urethane coating.

F. BENDS:

Uniform, whether job-fabricated or made with standard fittings or boxes. Do not dent or flatten conduit.

- 1) Exposed Conduit: Symmetrical insofar as practicable.

G. LOCATION:

- 1) Routing: Generally shown in schematic fashion, unless dimensioned or noted to contrary.
- 2) Conduit Not Shown: Contractor shall route as required to connect equipment as specified.
- 3) Vertical Risers, Equipment and Device Locations: Approximately as shown. Contractor shall coordinate installation of conduit, in locations indicated, with structure and equipment.

H. BURIED CONDUIT:

- 1) Depth of Burial: Minimum of 30" below finished grade.

I. WALL PENETRATIONS:

Required for passage of conduits installed by Contractor through walls, or partitions.

- 1) Penetrations Through Exterior Building Walls: Core drill foundation wall and provided conduit entrance seals as detailed.
- 2) Openings Required Through Existing Partitions: Shall be provided at Contractor's expense. Holes through masonry construction shall be drilled with suitable coring machine. Perform work neatly. Patches shall match original material in composition and appearance. Provide fire seals as detailed where a fire rated partition is penetrated.

J. EXPANSION FITTINGS:

Install in all conduit runs crossing structural expansion joint or in straight runs 75 feet or more in length.

K. CONDUIT ENDS: Cap spare conduit.

- 1) Open Conduit Ends Terminating in Switchboards, Cabinets or Similar Locations Where Exposed to Entrance of Foreign Material: Install insulating grounding bushing. Plug space around cables with oakum and/or sealing compound.
- 2) Cap or plug conduit ends to prevent entrance of foreign material.

L. CONDUIT CONNECTIONS:

- 1) Cabinets and Boxes: Double locknuts and insulating bushings for rigid conduits.
- 2) Cable Tray: Clamp conduit securely to tray. Install insulating bushing.
- 3) Metallic Conduit Terminating in Non-Metallic Manholes or Pullboxes: Insulated grounding bushing with lay-in ground lugs.
- 4) Flexible conduit for connection to movable equipment shall be liquid tight, sealtite as manufactured by Anacarda Metal Hose Company utilizing approved liquid tight fittings.

M. SUPPORTS:

Hangers and supports shall be galvanized or PVC coated. Hangers generally are not detailed but must be adequate to support combined weights of conduit. Rigid fastenings spaced maximum of 6'-0".

- 1) Clamps: Galvanized malleable iron one-hole straps, beam clamps or other approved device with necessary bolts, expansion shields. Perforated metal straps shall not be used.
- 2) Adjustable Hangers: Used to support horizontal runs only, use trapeze hangers for parallel runs of conduits. Install U-bolts or other approved clamping device at end of each run and at each elbow. Install clamp every third intermediate hanger for each conduit.

N. CLEANING:

Clean and swab inside of conduits by mechanical means to remove foreign materials and moisture before conductors are installed.

16050.3.2 CONDUCTOR INSTALLATION

- A. BENDING RADII: Not less than permitted by ICEA.
- B. SUPPORTS IN VERTICAL RUNS: As prescribed by NEC.
- C. SPLICING: Permitted only in junction boxes or similar accessible locations. Number of splices held to absolute minimum. Cover with heat shrinkable sleeves to make moisture proof and corrosive resistant.
- D. CONNECTORS: Soderless compression or mechanical type where screw does not bear directly on wire.
- E. ALL POWER CABLES: In strict accordance with manufacturer's instructions.
- F. CONNECTIONS:
 - 1) Apparatus Lugs: Tandem single or multi-barrel lugs as detailed.
- G. CONDUCTOR PULLING: Use pulling grips.
 - 1) Reels: Firmly mount on portable stand and secure against displacement.
 - 2) Lubrication: Use powdered soapstone or approved commercial pulling compound. Use of soap or other solutions not permitted.
- H. COLOR CODING:

Use green covering for conductors intended solely for grounding. Establish consistent color scheme throughout project insofar as practicable.

 - 1) Single-Phase Power: Use white for neutral conductor, black for ungrounded conductors.
 - 2) Three-phase service, feeder and branch conductors shall be color coded as follows:

120/208 VOLT

277/480 VOLT

a.	Phase A - Black	Brown
b.	Phase B - Red	Orange
c.	Phase C - Blue	Yellow
d.	Neutral - White	Grey
e.	Ground - Green or bare	Green or bare

- 3) Coding shall be by insulation color or minimum 1" band of colored tape.

16050.3.3 INSTALLATION OF POWER EQUIPMENT:

Provide all power and control wiring required for the work of other trades as described on the drawings and in the various sections of these specifications, except where the furnishing and installing of such wiring is specified elsewhere. Connect cored sets to Owner furnished equipment and make connection to all electric power consuming equipment whether furnished under contract or by Owner.

16065.1 GENERAL

16065.1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions

16065.1.2 SUMMARY

- A. Section includes lightning protection for structures.

16065.1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For air terminals and mounting accessories.
 - 1. Layout of the lightning protection system, along with details of the components to be used in the installation.
 - 2. Include indications for use of raceway, data on how concealment requirements will be met and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

16065.1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified installer and manufacturer. Include data on listing or certification by UL.
- B. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
- C. Field quality-control reports.
- D. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
- E. Other Information Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
 - 1. Ground rods
 - 2. Ground loop conductor

16065.1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.
- B. System Certificate:
 - 1. UL Master Label
 - 2. LPI System Certificate
 - 3. UL Master Label Recertification
- C. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

16065.1.6 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components and building finishes.

16065.2 PRODUCTS

16065.2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96 and NFPA 780
- B. Roof-Mounted Air Terminals: NFPA 780
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work included; but not limited to, the following:
 - 2. Basis of Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. VFC
 - b. East Coast Lightning Equipment, Inc.
 - c. ERICO International Corporation
 - d. Harger
 - e. Heary Bros. Lightning Protection Co., Inc.
 - f. Independent Protection Co.
 - g. Robbins Lightning, Inc.
 - h. Thompson Lightning Protection, Inc.
 - 3. Air Terminals More Than 24-inches Long: With brace attached to the terminal at not less than half the height of the terminal
 - 4. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in roofing Sections.
- C. Main and Bonding Conductors: Copper or aluminum.
- D. Ground Loop Conductor: The same size and type as the main conductor excepted tinned.
- E. Ground Rods: Copper-clad steel (sectional type): 5/8-inch in diameter by 96-inches long.
- F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Stainless steel, solid copper, lonel metal or lead sheathed.

16065.3 EXECUTION**16065.3.1 INSTALLATION**

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- C. Conceal the following conductors:
 - 1. System conductors
 - 2. Down conductors
 - 3. Interior conductors
 - 4. Conductors within normal view of exterior locations at grade within 200 feet of building.
- D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
- E. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
 - 1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.
- F. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.
- G. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.
- H. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure, area or item indicated.

1. Bury ground ring not less than 24 inches from building foundation.
 2. Bond ground terminals to the ground loop.
 3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.
- I. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

16065.3.2 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

16065.3.3 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protection coatings where conditions cause deterioration or corrosion of conductors.

16065.3.4 FIELD QUALITY CONTROL

- A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- B. UL Inspection: Meet requirements to obtain a UL Master Label for system.
- C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

16100.1 DESCRIPTION

Furnish and install buried cable for electrical controls and service of the size and location as shown on the Drawings and specified herein.

16100.1.1 RELATED WORK

Section 02200 - Trench Excavation and Backfill
Section 02222 - Pipe Installation
Section 16010 - Electrical General Requirements

16100.1.2 SUBMITTALS

Not used.

16100.1.3 DEFINITIONS

Not used

16100.2 MATERIALS**16100.2.1 CABLE**

Shall be the size and type as shown on the Drawings or Special Provisions. All cable shall comply with the requirements of the National Electrical Code and shall be specifically manufactured for direct burial.

16100.3 CONSTRUCTION REQUIREMENTS

All buried cable shall be installed as shown on the Drawings and in accordance with the requirements of the National Electric Code and Section 16010.

16100.4 METHOD OF MEASUREMENT**16100.4.1 NO SEPARATE MEASUREMENT**

Separate measurement will not be made when buried electrical cable is a component of another item listed in the Bid Schedule.

16100.5.2 SEPARATE MEASUREMENT

Measurement of buried cable shall be made using a tape measure or other accurate measuring device to determine the number of lineal feet of cable installed and accepted as identified in the Bid Schedule.

16100.5 BASIS OF PAYMENT**16100.6.1 NO SEPARATE PAYMENT**

Separate payment will not be made for buried electrical cable installed and accepted as a component of another item listed in the Bid Schedule.

16111.5.2 SEPARATE PAYMENT

The accepted quantity, when shown as an item in the Bid Schedule, will be paid for at the contract unit price for:

PAY ITEM	UNIT
Buried Cable (<i>size, type</i>)	Lump Sum

16150.1 GENERAL

16150.1.1 QUALITY ASSURANCE

- A. Comply with NFPA 70 requirements for electrical materials and installation.
- B. Provide products and components which have been UL listed and labeled, including UL marks indicating special type usage whenever applicable.

16150.2 PRODUCTS

16150.2.1 MOTOR STARTERS

- A. Acceptable Manufacturers:
 - 1. Allen-Bradley Co.
 - 2. Eaton Corp/Power Distribution Div.
 - 3. Cutler Hammer
 - 4. General Electric Co. (GE Supply)
 - 5. Square D Co.
- B. Provide factory fabricated starters complying with NEMA Standards Publication ICS 2 with NEMA Type enclosures as specified in Section 16010.
- C. Provide starters with thermal overload protection on each phase utilizing interchangeable melting alloy, Class 20 (trip in 20 seconds or less when carrying a current equal to 600 percent of its current rating) overload heaters, sized in field for full load current rating indicated on each motor nameplate.
- D. Manual Motor Starter: Quick-make, quick-break trip free toggle or pushbutton operating mechanism; provisions for positive padlocking in OFF position.
- E. Magnetic Motor Starter: Non-reversing or reversing, as indicated; manual reset overload relay with reset button on face of enclosure; full voltage starting; control transformer of sufficient capacity to handle operating coil and associated controls, integral with each starter; 120 volts control circuit, fuse protected; equipped with pilot light.

16150.2.2 CONTACTORS

- A. Acceptable Manufacturers:
 - 1. Allen-Bradley Co.
 - 2. Eaton Corp/Power Distribution Div.
 - 3. Culter Hammer
 - 4. General Electric Co. (GE Supply)
 - 5. Square D Co.
- B. Provide contactors complying with NEMA Standards Publication ICS 2 with NEMA Type enclosures as specified in Section 16010, unless otherwise indicated.

16150.2.3 RELAYS

- A. Acceptable Manufacturers:
 - 1. Control Relays:

2. Allen-Bradley Co.
3. IDEC Systems & Controls Corp.
4. Omron Electronics, Inc./Control Components Div.
5. Potter & Brumfield
6. Square D Co.

- B. Provide relays complying with NEMA Standards Publication ICS 2 with NEMA Type enclosures as specified in Section 16010, unless otherwise indicated.

16150.2.4 CONTROL PANELS

- A. Acceptable Manufacturers:

1. Allen-Bradley Co.
2. Eaton Corp/Power Distribution Div.
3. Cutler Hammer
4. Square D Co.

- B. Provide factory fabricated oiltight pushbuttons, selector switches, pilot (indicating) lights, and pushbutton stations complying with NEMA Standards Publication ICS 2, heavy duty, with NEMA Type enclosures as specified in Section 16010.

1. Fabricate pushbutton stations for vertical or horizontal mounting, as indicated, and with button and light arrangements, as indicated on drawings.

- C. Pushbuttons: Momentary or maintained contacts, as indicated; contacts rated 10 amps continuous carrying current, 600 volts AC; quick-make, quick-break, snap action operating mechanism.

- D. Selector Switches: Rotary type; two or three position control, as indicated; legend plate with markings as indicated.

- E. Pilot Lights: Transformer type, 120 volts AC; glass or acrylic plastic prismatic lens, color as indicated; legend plate with markings as indicated.

16150.2.5 CIRCUIT AND MOTOR DISCONNECTS

- A. Acceptable Manufacturers:

1. Cutler Hammer
2. Allen-Bradley Co.
3. Siemens Corp/Electrical Apparatus Div.
4. Square D Co.
5. General Electric Co. (GE Supply)

- B. Provide factory fabricated switches complying with NEMA Standards Publication KS 1 with NEMA Type enclosures as specified in Section 16010.

- C. Safety Switches: 3 pole, heavy-duty, horsepower rated disconnect; rated at 600 volts; quick-make, quick-break operating mechanism; integral operating handle provided with means for positive padlocking in OFF position; current carrying parts constructed of high conductivity copper, with silver-tungsten type switch contacts; fusible or non-fusible as indicated; positive pressure type reinforced fuse clips for fusible switches.

- D. Fuses: Dual element type, with time delay; non-renewable; current limiting where indicated.

16150.2.6 TRANSFER SWITCHES – MANUAL

- A. Acceptable Manufacturers:
1. Cutler Hammer
 2. Square D Co.
 3. General Electric Co. (GE Supply)
- B. Provide manual transfer switches complying with NEMA Standards Publication KS 1, specifically designed to transfer power from one load to another load, with NEMA Type enclosures as specified in Section 16010.
- C. Manual Transfer Switches: Double throw, 3 pole, heavy-duty, safety switch; rated at appropriate amperes, 600 volts; quick-make, quick-break operating mechanism; blades visible from front of unit for positive indication that switch is OFF; integral three position operating handle provided with means for positive padlocking in OFF position; current carrying parts constructed of high conductivity copper, with silver-tungsten type switch contacts; non-fusible.

16150.3 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

- 16150.3.1 These control devices shall be considered pertinent to the equipment which they are associated with. They will not be measured or paid for separately, but shall be included in other appropriate bid items.

16210.1 DESCRIPTION

The Contractor shall provide and install all lighting systems for the Project, complete with lamps, brackets, hangers, mounting devices and all other miscellaneous components required to complete the lighting system as shown on the Drawings and in accordance with these Specifications.

16210.1.1 RELATED WORK

Section 16010 - Electrical General Requirements

16210.1.2 SUBMITTALS

Shop drawings shall be submitted for all light fixtures in accordance with Section 1300 of these Specifications.

16210.1.3 DEFINITIONS

Not used.

16210.2 MATERIALS**16210.2.1 LIGHTING FIXTURE TYPES AND SIZES**

Shall be as designated on the Drawings or as otherwise required by the Special Provisions. All work, equipment, and materials shall be in accordance with UL "Standards for Electric Lighting Fixtures", No. 57, and the NEC (National Electric Code).

16210.2.2 INCANDESCENT FIXTURES

Shall be complete with medium base socket, all hardware required for installation, and lamps. Lamps shall be medium base, inside frosted, general purpose, or the project type as referenced in the electrical schedule.

16210.2.3 FLUORESCENT FIXTURES

Shall be provided complete with Class "P" high power factor, electronic type ballast with a -20°F temperature rating, together with all miscellaneous hardware and lamps. Ballast shall be CBM certified, ETL rated, with maximum sound level equivalent to General Electric Company Sound Rating "A". Lamps shall be cool white unless otherwise required on the Drawings.

16210.2.4 HIGH INTENSITY DISCHARGE FIXTURES

Shall be ballast type, complete with all miscellaneous hardware and lamps. Photocells shall be used as required on the Drawings. Ballast shall be constant wattage, high power factor type. Lamps shall be inside frosted and of the wattage indicated.

16210.2.5 HIGH PRESSURE SODIUM FIXTURES

High-pressure sodium and metal halide fixtures shall be suitable for all burning positions as specified for each type of luminaire.

16210.3 CONSTRUCTION REQUIREMENTS

16210.3.1 Fixtures and related materials shall be installed as nearly as possible in the locations shown on the Drawings. The Contractor shall coordinate the exact locations with structure, equipment, and other devices as approved by the Engineer and/or the Owner. Mounting heights shall be as indicated on the Drawings.

16210.3.2 Conductors serving grid ceiling fixtures shall be enclosed in 1/2 inch flex conduit from a junction box attached to the building structure. Fixture locations shall be coordinated with ceiling system. Fixtures shall be securely fastened to the ceiling framing members.

16210.4 METHOD OF MEASUREMENT

Measurement for the lighting fixtures will not be made separately but will be included in the measurement for the building listed in the Bid Schedule.

16210.5 BASIS OF PAYMENT

Separate payment will not be made for light fixtures. Payment will be included in the contract unit price for the building in which the fixtures are installed and listed in the Bid Schedule.

16400.1 GENERAL**16400.1.1 APPLICABLE SECTIONS**

The General Conditions, Supplementary General Conditions, Special Conditions, Alternates and addenda, applicable drawings and the technical specifications herein shall apply to all work under this Division 16.

16400.1.2 SCOPE

Provide all operations, methods, labor and equipment and provide and install all materials and incidentals necessary for the completion of the work as specified herein or included on the drawings.

16400.1.3 WORK INCLUDED

- A. Electrical work required for this work is shown on the drawings and includes, but is not necessarily limited to:
 - 1. Complete new electrical distribution system for power and lighting as shown.
 - 2. Complete system of raceways and outlets for Control and all other auxiliary systems of this Division 16. Unless noted otherwise, the equipment and wiring of these auxiliary systems will be furnished and installed under their respective sections; however, the conduit raceway systems will be furnished and installed under this Section 16400.
 - 3. All excavating, backfilling, compacting, and grading required for the installation of all work covered under this Division 16.
- B. Shall furnish and install all component parts of all the systems required for their safe and proper operation, whether or not specifically mentioned or noted on the drawings, except those items or articles which are specifically noted hereinafter as being supplied otherwise.
- C. Perform all trenching and backfilling required in connection with the work of this section in strict accordance with the provisions of Division 02000 of these specifications.
- D. Provide all required electrical connections and service to items described in all other sections of these specifications. Provide all those services outlined in other divisions of the specifications as being done by the electrical sub-contractor.

16400.1.4 RELATED WORK SPECIFIED ELSEWHERE:

Section 16010 – Electrical General Requirements
Section 16410 – Fuses

16400.2 PRODUCTS

16400.2.1 DISTRIBUTION PANELBOARDS

- A. Distribution panelboards shall be factory assembled dead front, wall mounted as scheduled and braced for the indicated ampere rms symmetrical with equipment, bussing connections, circuit breakers and all similar components indicated on the drawings or required for proper completion. Each breaker shall have an etched micarta nameplate secured by two cadmium plated screws. Nameplates shall indicate equipment served as shown in schedule. Busses shall be copper of a maximum current density of 1000 amperes per inch and shall be equipped with uninsulated equipment ground bus. Three phase, 4-wire panels shall have full capacity neutral bus.
- B. All floor mounted panels shall be mounted on a **4" housekeeping pad** and therefore to comply with NEC, the operating handles of switches and breakers shall be no more than 6'-2" above the bottom of the panel.
- C. Distribution panel boards shall be wall mounted as indicated in schedules. For access to wiring gutters, panel shall be door within door construction. Shall be Square D, I-Line or equal of Siemens I.T.E., Cutler Hammer/Westinghouse or General Electric.

16400.2.2 BRANCH CIRCUIT PANELBOARDS

- A. Branch circuit panelboards shall be Square D for the scheduled voltage, 3 phase, 4 wire operation or equal of Siemens, or General Electric. Shall be equipped with bolt-on breakers. Minimum width shall be 20 inches. Minimum depth shall be 5.75 inches. Panel trims shall be of the door within door construction.
- B. Busses shall be copper.
- C. Branch circuit breakers shall be provided per schedules on drawings. All multi-pole breakers shall be common trip.
- D. Doors shall be complete with corrected circuit schedule on inside. Panels shall be NEMA 3R type construction.

16400.2.3 DRY TYPE TRANSFORMERS

- A. General Purpose Dry-Type Transformers: (Under 600 volts)
 - 1. General: Furnish and install at locations shown on the drawings dry-type two winding power transformers for general power and lighting applications indicated. Transformers shall be UL listed and bear the required Listing Mark.
 - 2. Electrical Rating: Shall be 60 hertz of sizes, phases, high voltage and low voltage as scheduled on the drawings. Each transformer, unless specifically noted otherwise, shall have six (6) 2-1/2% full capacity taps, two above and four below nominal voltage in the high voltage winding. Temperature Classification: Each transformer shall utilize an insulation system that has been properly temperature classified and approved by Underwriters' Laboratories. Unless specifically noted otherwise, the insulation classification shall be 220 C with 150 C winding temperature rise in accordance with Underwriters' Laboratories specification UL506.

3. Load Rating:

- a. Each transformer supplied to this specification shall be capable of operating at 100% of nameplate rating (NPR) continuously while in an ambient temperature not exceeding 40°C and shall be capable of meeting the daily overload requirements of ANSI Standard C57.96 as stated in the following chart:

PERMISSIBLE ONCE DAILY OVERLOADS WITH NORMAL LIFE MAINTAINED			
Peak Load Following and Followed by a Constant Load of			
Peak Load Time (Hours)	90% NPR	70% NPR	50% NPR
1/2	162% NPR	185% NPR	200% NPR
1	138% NPR	148% NPR	152% NPR
2	123% NPR	128% NPR	133% NPR
4	113% NPR	115% NPR	118% NPR
8	106% NPR	107% NPR	108% NPR

NPR = Nameplate Rating

- b. Transformer loaded in accordance with this paragraph shall be capable of long service life under the thermal conditions specified. There shall be no need for derating.

4. Sound Rating: Each transformer shall have sound levels equal or lower than those established in the latest revision of ANSI Standard C89 as shown in the following chart:

Transformer Rating KVA	Maximum Sound Level Decibels
10-50	45
51-150	50
150-300	55

5. Other Requirements: The following requirements shall be in accordance with Underwriters' Laboratories specification UL506:

- a. Enclosure:
 - (i) Ventilation openings
 - (ii) Corrosion resistance
 - (iii) Cable bending space
 - (iv) Grounding provisions
 - (v) Surface temperature rise
 - (vi) Wiring compartment temperature rise
 - (vii) Terminations

6. Test Requirements:
 - a. Each transformer furnished to this specification shall be subjected to the following production tests:
 - (i) Applied potential
 - (ii) Induced potential
 - (iii) No load losses
 - (iv) Voltage ratio
 - (v) Polarity
 - (vi) Continuity
 - b. The manufacturer shall have performed the following additional tests on units identical to the design type being furnished to this specification. Proof of performance of these lists in the form of test data sheets shall be provided as part of the shop drawing submittal.
 - (i) Sound levels
 - (ii) Temperature rise tests
 - (iii) Full-load losses
 - (iv) Regulation
 - (v) Impedance
7. Shop Drawings: Submit shop drawing for review prior to delivery to job site.

16400.3 EXECUTION

16400.3.1 INSTALLATION OF GROUNDING SYSTEM

- A. The conduit system and neutral conductor of the wiring system shall be grounded to the cold water pipe having a continuous path to earth in compliance with grounding provisions as outlined in the NEC. Point of connection to the water system shall be as near as practicable to the service entrance. Provide bonding jumper same size as system ground to provide ground continuity from customer's side of metallic lines service entrance and street side of metallic mains. The neutral and ground shall be connected together at the main service switch only.
- B. Where the water main is not metallic, delete water pipe ground requirements and provide a concrete encased electrode consisting of a 20-foot length of #3/0 bare copper conductor tied to the steel reinforcing bars and encased within a concrete footing. This footing shall be in direct contact with earth and located near the main panel.
- C. The Contractor shall also install a made electrode ground system consisting of copperclad rods spaced not closer than six feet apart. Grounding conductors and connections to ground rods shall be protected from damage and shall be placed to avoid disconnect by unauthorized personnel. Interconnect with water pipe ground system.
- D. The equipment grounding system shall be such that all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity with the electrical circuits operate continuously at ground potential and provide a low impedance path for the possible ground fault currents. The system shall comply with the National Electrical Code, modified as indicated on the drawings or specifications and as hereinafter specified to incorporate a maximum 25 ohms ground resistance. Grounding connections shall be accessible for inspection.

- E. The distributions system shall be provided with a separate equipment grounding conductor for each single or three-phase feeder, each branch circuit with a multi-pole protective device and each single phase receptacle and motor circuit as indicated. The required grounding conductor shall be installed in the common raceway with the related phase and/or neutral conductors. Single-phase branch circuits required for lighting, shall consist of phase and neutral conductors installed in common metallic conduit which shall serve as the grounding conductor. Conduit equipment connections utilized in conjunction with the above single-phase branch circuits shall be provided with suitable bonding jumpers connected to approved grounding type bushings. Single-phase branch circuits and all branch circuits installed in flexible conduits shall be provided with a separate grounding conductors as hereinbefore specified for the multi-pole branch circuits.

16400.3.2 INSTALLATION OF PANELS

- A. Installation: Unless otherwise indicated on the drawings, install wall panels with the top of the trim 6'-0" above the finished floor. Panels located in equipment rooms and wire closets shall be surface mounted. Floor mounted panels shall be provided with a 4" concrete housekeeping pad. Floor mounted panels shall be anchored to floor at all four corners and to wall or structural member at top for seismic restraint.
- B. Directories: Mount a typewritten directory behind glass or plastic on the inside of each panel door. On the directory, show the circuit number and complete description of all outlets with specific locations on each circuit. In addition, provide a typewritten label inside door showing source of power to panel both as to feeder switch, panel designation and location within buildings.

16400.3.3 GENERAL PURPOSE DRY TYPE TRANSFORMERS

General purpose dry transformers shall be mounted on floor at locations shown on drawings. Each shall be anchored to floor by means of a minimum of four 1/2" x 6" anchor bolts grouted in existing concrete floor.

16400.3.4 TESTING

- A. General: Upon completion of this portion of the work, test all parts of the electrical system in the presence of the Engineer Owner's Representative.
- B. Test Requirements: All systems shall test free from short circuits and grounds, shall be free from mechanical and electrical defects, and shall show an insulation resistance between phase conductors and ground of not less than that required by the National Electrical Code.

16400.3.5 FINAL INSPECTION

- A. This Division 16 contractor's job foreman shall be present at the final inspection of the work by the Owner.
- B. Electrical job foreman shall have pad and pencil to list all deficient items noted. Corrections and adjustments of deficient items shall be done after the inspection, not during.
- C. See Section 16010 for other requirements for final inspection.

16400.4 METHOD OF MEASUREMENT

- 16400.4.1 SERVICE ENTRANCE. Provide all conduit, sweeps, support members, concrete transformer pads & pad vaults, grounding equipment, breakers, disconnects, enclosures, conductors, and appurtenances as required by the local utility, and as shown on the drawings and as defined in the applicable sections of the specifications required for a complete and fully functioning system.
- 16400.4.2 GROUNDING SYSTEM. Provide all grounding conductors, connections, ground rods, ground wells, and associated appurtenances and as shown on the drawings, and as defined in the applicable sections of the specifications.
- 16400.4.3 POWER PANEL (PP) OR MOTOR CONTROL CENTER (MCC). Provide all conduit, sweeps, pull boxes, power panels, motor starters, motor savers, receiving and installation of motor control center, transient voltage surge suppressor (TVSS), support members, grounding equipment, breakers, disconnects, enclosures, conductors and connections, and appurtenances as shown on the drawings and as defined in the applicable sections of the specifications required for a complete and functioning system.
- 16400.4.4 DRY TYPE TRANSFORMERS. Provide dry type transformer and appurtenances as shown on the drawings and as defined in the applicable sections of the specifications required for a complete and functioning system.
- 16400.4.5 LIGHTING PANEL (LP). Provide all conduit, sweeps, support members, grounding equipment, breakers, disconnects, enclosures, conductors and connections, switches, receptacles, and appurtenances as shown on the drawings and as defined in the applicable sections the specifications required for a complete and functioning system. Where lighting fixtures are not called out in the pay item, they are included in the LIGHTING PANEL (LP).
- 16400.4.6 LIGHTING FIXTURES. Material cost for lighting fixtures and all appurtenances. Note: conduit, wire and switches and included in LIGHTING PANEL (LP) section(s).
- 16400.4.7 HEATING VENTILLATION AIR CONDITIONING (HVAC). Provide all conduit, sweeps, support members, grounding equipment, breakers, disconnects, enclosures, conductors, switches, receptacles, and appurtenances as shown on the drawings and as defined in the applicable sections the specifications required for a complete and functioning system. Note: conduit, wire and switches and included in LIGHTING PANEL (LP) section(s).
- 16400.4.8 CONTROL PANELS. Provide all conduit, signal and power conductors and connections, and appurtenances for all control panels as shown on the drawings and as defined in the applicable sections of the specifications required to provide a complete and functioning system.

16400.5 BASIS OF PAYMENT

- 16400.5.1 No separate payment shall be made for furnishing or installing electrical systems, components, or materials required to be installed within the pay limits for a building or enclosure identified in the BID schedule to be furnished by the Contractor.
- 16400.5.2 When electrical systems, components, or materials are measured for a new building or enclosure as shown on the Bid Schedule, separate payment will be made as listed below.
- 16400.5.3 When initial installation or replacement of electrical systems, components, or materials is made in an existing building as shown on the Bid Schedule, the accepted quantity will be paid for at the contract price listed below:

PAY ITEM	UNIT
Service Entrance	Lump Sum
Grounding System	Lump Sum
Lighting Panel LP1 & Control Panel	Lump Sum
Lighting Fixtures	Lump Sum
HVAC	Lump Sum
Control Panels	Lump Sum

DIVISION 17

INSTRUMENTATION AND CONTROLS

17000.1 SUMMARY

General requirements that apply to all process control and instrumentation systems for the entire project, reference P&ID drawings, and any other supplementary or special provisions specifications.

17000.1.1 RELATED SECTIONS:

17000.1.1.1 In addition to the responsibilities listed below, the CONTRACTOR shall be responsible for all requirements of Section 16 and Section 17.

17000.1.1.2 The CONTRACTOR shall provide all hardware and will be responsible for delivering a complete and functioning system, as well as any support needed by the INTEGRATOR to accomplish their tasks.

17000.1.1.3 The primary responsibility of the INTEGRATOR is to provide programming for any and all PLCs, OITs, HMI, or any other controls or communications equipment included in the scope of this project. It is also the responsibility of the INTEGRATOR to completely integrate new equipment and programming to fully function with any existing controls and SCADA equipment. New equipment and existing equipment shall function together as one cohesive system unless otherwise specified in project plans.

17000.1.1.4 Other parts of the work such as supplying of equipment, panel drawings, submittal submission, site communication survey and design, etc., may be transferred to the INTEGRATOR for completion. The details of this transaction such as scope of work and compensation, are to be worked out between the CONTRACTOR and INTEGRATOR. Ultimately it will be the responsibility of the CONTRACTOR to deliver a complete and functioning system.

17000.1.1.5 The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

17000.1.1.6 Items involving electrical, control, and instrumentation construction may be shown on drawings or referred to in specifications that do not apply specifically to electrical, control and instrumentation systems. Because the Contract Documents are a single integrated document, it is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

17000.1.2 The CONTRACTOR shall note that the instrument equipment specifications and installation details are based on preliminary vendor information and indicate minimum scope of supply from the equipment manufacturer. The CONTRACTOR shall include all costs in its bid to add additional instruments, wiring, computer inputs/outputs, controls, conduit, interlocks, electrical hardware, etc., into the design based on the equipment manufacturer's final certified vendor drawings. The CONTRACTOR shall revise or produce new loop diagrams to meet the equipment manufacturer's wiring requirements. Such changes to instrumentation and electrical work shall be incorporated into the scope of work at no additional cost to the OWNER.

17000.2 REFERENCES

17000.2.1 CODES AND REGULATORY COMPLIANCE.

17000.2.1.1 The equipment, materials, installation, and other work shall conform to all applicable regulations, standards, specifications, and codes which are current as of the date of the final inspection for this Contract.

17000.2.1.2 The equipment, materials, installation, and other work shall conform to all applicable regulations, standards, specifications, and codes which are current as of the date of bidding for this Contract, including, but not limited to, those which are established by the following sources:

- A. Instrument Society of America (ISA).
- B. National Electrical Manufacturers Association (NEMA).
- C. Occupational Safety and Health Administration (OSHA).
- D. American National Standards Institute (ANSI).
- E. National Fire Protection Association (NFPA).
- F. Institute of Electrical and Electronic Engineers (IEEE).
- G. National Electrical Code (NEC).
- H. Insulated Cable Engineers Association (ICEA).
- I. Federal Communications Commission (FCC).
- J. Underwriters Laboratory (UL).
- K. Local Power and Telephone Companies.
- L. Local Authorities having jurisdiction over the work.

17000.2.2 Where the requirements set forth in these Specifications or on the Drawings are greater or more rigid than the mandatory requirements referenced above, the applicable Specifications or Drawings shall govern.

17000.2.3 In the case of conflict between any mandatory requirements and Specifications or Drawings, the mandatory requirement shall be followed in each case, but only after submitting such proposed changes to the ENGINEER for approval.

17000.2.4 The Drawings and Specifications are complementary to each other; what is called for by one shall be as binding as if called for by both. If a conflict between Drawings and Specifications is discovered, this shall be referred to the ENGINEER as soon as possible for resolution. Should a conflict exist between the Drawings, Specifications, and/or mandatory requirements (i.e., codes, ordinances, etc.), it will be assumed that the more expensive method has been estimated, unless such alternate has been agreed to prior to submission of bids.

- 17000.2.5 SAFETY: The site responsibility of the ENGINEER is limited solely to the activities of the ENGINEER and its employees on site. These responsibilities shall not be inferred by any party to mean that ENGINEER has responsibility for site safety. Safety on or about the site is the sole and exclusive responsibility of the CONTRACTOR. The CONTRACTOR'S methods of work performance, superintendence of the CONTRACTOR'S employees, and sequencing of construction are also the sole and exclusive responsibilities of the CONTRACTOR. The OWNER warrants that: 1) The CONTRACTOR'S responsibilities will be made clear in the owner's agreement with the CONTRACTOR; 2) The owner's agreement with the CONTRACTOR shall require the CONTRACTOR to indemnify, defend, and hold OWNER and ENGINEER harmless from any claim or liability for injury or loss arising from owner's or engineer's alleged failure to exercise site safety responsibility; 3) owner's agreement with the CONTRACTOR shall require the CONTRACTOR to make OWNER and ENGINEER additional insured under the CONTRACTOR'S general liability insurance policy, which insurance protection shall be primary protection for OWNER and ENGINEER. Given the foregoing, OWNER also shall, to the fullest extent permitted by law, waive any claim against ENGINEER, and indemnify, defend, and hold ENGINEER harmless from any claim or liability for injury or loss arising from engineer's alleged failure to exercise site safety responsibility. OWNER shall also compensate ENGINEER for any time spent or expenses incurred by ENGINEER in defense of any such claim. Such compensation shall be based engineer's prevailing fee schedule and expense reimbursement policy.
- 17000.2.5.1 The term "any claim" used in this provision means "any claim in contract, tort, or statute alleging negligence, errors, omissions, strict liability, statutory liability, breach of contract, breach of warranty, negligent misrepresentation, or other acts giving rise to liability."
- 17000.2.5.2 The term ENGINEER used in this provision means the prime engineer and all sub-engineers, sub-consultants, Electrical Engineers, Process Engineers, and Control Systems Engineers.

17000.3 DEFINITIONS

- 17000.3.1 DEFINITIONS: Definitions of terms and other electrical considerations as set forth in the:

NEC: National Electrical Code.
IEEE: Institute of Electrical and Electronic Engineers.
ISA: Instrument Society of America.
NFPA: National Fire Protection Association.
NETA: National Electrical Testing Association.

- 17000.3.2 SPECIFIC DEFINITIONS:

MTU: Master Terminal Unit.
RTU: Remote Terminal Unit.
FAT: Factory acceptance test.
HMI: Human Machine Interface.
LCP: Local Control Panel containing operator interface devices operators, etc. without a PLC.
LAN: Local Area Network.
WAN: Wide Area Network.
PC: Personal Computer.
PLC: Programmable Logic Controller.
RIO: Remote I/O.
OIT: Operator Interface Terminal.
SCADA: Supervisory Control and Data Acquisition system incorporating and including all parts of the PLCs, PCs, OITs, RIOs, MTUs, etc.

17000.4 SYSTEM DESCRIPTION

In accordance with:

Section – 17050 Control Strategies, General
Section – 17050SP Control Strategies, Special Provision
Section – 17100 Instrumentation Control Panels, General
Section – 17100SP Instrumentation Control Panels, Special Provision

17000.5 SUBMITTALS

In accordance with Section 01300 Submittals. In addition, CONTRACTOR will furnish the following:

- 17000.5.1 GENERAL. Submit shop drawings, product data, operating manuals, power calculations, communication architecture plans, and all other required documents. Submittals shall show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers and all other pertinent details. Submittals shall be organized and delivered for review by specification section.
- A. There may be multiple submittals for a single specification. A submittal on designs and equipment with anticipated long lead times may reduce the impact the submittals have on the project schedule. ENGINEER may request additional design or portions be submitted before approval of partial submittals.
 - B. Single submittals covering multiple specification sections will be returned without review. The ENGINEER will be reimbursed by the OWNER for all subsequent reviews and the OWNER will deduct the amount of the reimbursement from the CONTRACTORS' contract. The ENGINEER'S reimbursement will be on a time and expense basis and at the current billing rate of the ENGINEER. The ENGINEER will be the sole source for determining the suitability of any submittal.
 - C. Submittals shall be fully indexed with title pages for each section. Pages within sections shall be sequentially numbered. Submittals that are not organized containing the proper sections with sequentially numbered pages, or are otherwise unacceptable, will be returned without review. The ENGINEER will be reimbursed by the OWNER for all subsequent reviews and the OWNER will deduct the amount of the reimbursement from the CONTRACTOR'S contract. The ENGINEER'S reimbursement will be on a time and expense basis and at the current billing rate of the ENGINEER. The ENGINEER will be the sole source for determining the suitability of any submittal.
 - D. During the period of preparation of this submittal, the CONTRACTOR shall authorize direct, informal liaison between the INTEGRATOR and the ENGINEER for exchange of technical information. As a result of this liaison, certain minor refinements and revisions in the systems as specified may be authorized informally by the ENGINEER, but these shall not alter the scope of work or cause increase or decrease in the contract price. During this informal exchange, no oral statement by the ENGINEER shall be construed to give formal approval of any component or method, nor shall any statement be construed to grant formal exception to, or variation from these Contract Documents.
 - E. The ENGINEER has allowed for up to and including two reviews of each submittal. The ENGINEER shall be reimbursed for all reviews after the first two reviews by the OWNER, and the OWNER will deduct the amount of the reimbursement from the contractor's contract. The engineer's reimbursement shall be on a time and expense basis and at the current billing rate of the ENGINEER. The ENGINEER shall be the sole source for determining the suitability of any submittal.

17000.5.2 ORGANIZATION: The submittal shall be presented in several parts in the following order. Any incomplete submittal will be rejected and returned without comments.

- A. Cover Page
- B. Table of Contents.
- C. Resubmittal Answers.
- D. Proposed Network Architecture.
- E. Shop Drawings.
- F. Complete project Bill of Materials.
- G. Hardware submittals.
- H. Power calculations.
- I. Testing and start-up procedures.
- J. Training submittals.

17000.5.3 COVER PAGE

- A. Cover page shall contain the following information:
 - 1. Project name and number.
 - 2. Specification section reference.
 - 3. Name and email address of individual who prepared submittal.
 - 4. Name and email address of individual who reviewed submittal prior to delivery to ENGINEER.
 - 5. CONTRACTOR review stamp and comments.

17000.5.4 TABLE OF CONTENTS: Table of contents shall list all sections and documents in the submittal with the corresponding page number.

17000.5.5 RESUBMITTAL ANSWERS

- A. If resubmittal, this page shall contain a response to each of the ENGINEER's comments and/or questions.
- B. Referenced by index section and page number on which the comment appeared.

17000.5.6 PROPOSED NETWORK DIAGRAM: One or more block diagrams showing communication between all sites involved in the project. This includes any local site communication and any communication to a central MTU or HMI.

17000.5.7 SHOP DRAWINGS: In accordance with Section 17100 – Instrumentation Control Panels General, shop drawings shall be submitted for each manufactured panel.

- A. All drawings must be complete, reviewed, and ready for manufacturing.
- B. Submittal approval is required before manufacturing of any panel is to begin.
- C. CONTRACTOR shall follow all requirements in Section 17100.1.4 - SHOP DRAWINGS in the Contract Documents.
- D. The CONTRACTOR shall respond to all comments on shop drawing re-submittals made by the ENGINEER either by making the noted correction or stating why it was not revised.

1. Any re-submittal received by the ENGINEER, which does not contain responses to the engineer's previous comments, shall be returned to the CONTRACTOR marked "REJECTED."
2. No further review by the ENGINEER shall be performed until a response for these comments has been received.

17000.5.8 PROJECT BILL OF MATERIALS: List of all materials that will be used to meet the project requirements. Equipment to be associated with the Instrumentation and Controls section of the Project Documents. Information includes identification number, manufacturer, manufacturer part number, and quantity.

17000.5.9 HARDWARE SUBMITTALS: Submittal data for each instrument or equipment in the Bill of Materials.

- A. Each submittal data entry shall have a separate cover sheet listing reference number, manufacturer, part number, description, and other important information. Exceptions to the project plans and specifications seeking approval shall be noted.
- B. For submittals that cover a device used in multiple different areas under the same specification section, the submittal for the individual devices must list the area where the device is intended to be used.
- C. Any part lists, data sheets, user manuals, or other submittal data that contains information for multiple parts or part configurations shall have all other information crossed out or otherwise removed for any equipment not pertaining to the submittal equipment.
- D. Any component that is an exception to specifications, deviation from contract documents, or a requested substitution shall be clearly marked as "Exception" along with a brief explanation of each. Acceptance of the exceptions is at the sole discretion of the ENGINEER. All items not listed as exceptions shall be furnished in accordance with the specifications and drawings. All items that do not meet the requirements of the specifications, and were not previously accepted as exceptions, shall be replaced by the CONTRACTOR at no additional cost to the OWNER, even if the submittals were approved with incorrect equipment.
 1. Any exceptions to the specifications must be noted, and the reason for the exception delineated. If there is no back up for the deviation, the submittal will be returned requiring revision and re-submit.

17000.5.10 POWER CALCULATIONS: Power calculations to show that the following meet the specified requirements:

- A. Power supply size to provide power to all instrumentation, equipment, and battery charging circuit. Power supplies shall be sized to 20% over maximum power draw.
- B. Battery capacity to power all equipment for the required time.
- C. Time to replenish depleted batteries after power is restored.

17000.5.11 TESTING AND STARTUP PROCEDURES: System test and start-up procedures and sequences shall be developed by the INTEGRATOR in conjunction with the CONTRACTOR and other requirements as identified in these Contract Documents and shall be submitted to the ENGINEER for review. An approved submittal shall be required prior to the commencement of system testing. Procedures shall be prepared for each process system. ENGINEER or OWNER's representative shall be present during completion of these tests unless otherwise specified.

- A. The procedures shall, in narrative form, describe sequentially the operational steps to be followed in verifying the correct operation of each process system, including all features described in the control strategies contained in Specifications Section 17050, and those reflected in the P&IDs.
- B. All equipment, constituting the complete control system and its various workstation displays, which function together to form a complete process system shall be tested together, including interlocks between devices. Test procedures for all process orientated systems shall be developed and performed.
- C. Test Procedure Submittals. Submit the proposed procedures to be followed during tests of the control system and its components.
- D. Provide certified and witnessed test and calibration checklists for each of the following tests:
 - 1. Factory Acceptance Tests.
 - 2. Loop Validation Tests.
 - 3. Pre-commissioning Test.
 - 4. Post-installation Startup Test.

17000.5.12 TRAINING SUBMITTALS. Operator and Maintenance Training plan which includes:

- A. A submittal of the training plan overview along with prerequisites for the OWNER'S personnel.
- B. Schedule of training courses including dates, durations, and locations of each class.
- C. Proposed training material, including a resume, and a detailed outline of each lesson.
- D. Resumes for the proposed instructors, indicating previous instructional experience.
- E. Course Outline.

The ENGINEER will review the submitted data for suitability and provide comments that shall be incorporated into the course.

17000.7 DELIVERY, STORAGE AND PROTECTION

17000.7.1 All equipment and materials delivered to the job site shall be stored in a location which will not interfere with the operations of the CONTRACTOR, other contractors on the site, or the OWNER.

17000.7.2 Storage and handling will be performed in manners which will afford maximum protection to the equipment and materials. Environmental conditions such as heat, humidity, and other ambient conditions must be accounted for. Instruments shall be stored in complete conformance with the manufacturer's recommendations. Any instruments stored in variance with the manufacturer's recommendations shall be replaced at the engineer's discretion at no additional cost to the OWNER.

17000.7.3 It is the CONTRACTOR'S responsibility to ensure proper handling and on-site storage of instrumentation and control equipment.

- 17000.7.4 SHIPPING PRECAUTIONS: After completion of shop assembly, factory test, and approval, all equipment, cabinets, panels, and installation materials shall be packed in a protective manor for shipping and delivery. Any equipment that is damaged during shipping shall be repaired or replaced by the INTEGRATOR at no additional cost to the OWNER.
- 17000.7.5 SPECIAL INSTRUCTIONS. Special instructions for proper field handling, storage, and installation required by the INTEGRATOR shall be securely attached to each piece of equipment prior to packaging and shipment.
- 17000.7.6 TAGGING. Each component and/or instrument shall be tagged to identify its location, instrument tag number, and function in the system.
- A. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the control system.
 - B. Instruments shall be tagged immediately upon receipt in the field.
 - C. Identification shall be prominently displayed on the outside of the package.
 - D. Tags shall utilize the Tag and Loop Number identifications shown of the P&IDs.

17000.8 SEQUENCING AND SCHEDULING

- 17000.8.1 FACTORY ACCEPTANCE TEST (FAT). Prior to the delivery and installation of the SCADA system at the job site, but after the procurement, assembly, and configuration of all components, the System Supplier shall conduct a factory test.
- A. The CONTRACTOR shall schedule the factory test after receiving approval of the factory test procedures submittal.
 - B. A copy of the test procedures shall be submitted to the ENGINEER at least 21 working days before the scheduled test date.
 - C. Notify the ENGINEER of scheduled tests a minimum of 15 working days prior to the date of the test.
 - D. Transmit completed PLC I/O Test Checklist forms 5 working days prior to the FAT.
- 17000.8.2 LOOP VALIDATION TEST. The CONTRACTOR shall notify the ENGINEER of scheduled tests a minimum of 30 working days prior to the estimated completion date of installation and wiring of the control system.
- A. Testing shall be completed 5 working days prior to the Pre-commissioning phase of the project.
 - B. Loop Validation Certifications. After the field device loop tests have been successfully completed for all individual instruments, all separate analog control networks, all valves all motors, all local operator interface panels, all motor control centers etc. a certified copy of all test forms signed by the INTEGRATOR and the OWNER'S representative as a witness, with test data entered, shall be submitted to the ENGINEER together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected, and tested.

- 17000.8.3 PRE-COMMISSIONING TEST. The INTEGRATOR shall furnish the services of an on-site commissioning engineer to supervise and coordinate installation, adjustment testing, pre-commissioning and start-up of the control system.
- A. The commissioning engineer shall be present during the total period required to affect a complete operating system. The commissioning engineer must be the individual responsible for the programming of the PLC's.
 - B. Shall commence after acceptance of all training, wire test, calibration tests and loop validation tests, and all inspections have demonstrated that the instrumentation and control system complies with all Contract requirements.
- 17000.8.4 TRAINING. The training sessions shall be scheduled a minimum of 3 weeks in advance of when the courses are to be initiated. The ENGINEER will review the course outline for suitability and provide comments that shall be incorporated.
- A. Documentation. Training plans shall be submitted to the ENGINEER a minimum of 10 working days prior to starting the training session. Within 10 days after the completion of each session the System Supplier shall submit through the CONTRACTOR the following:
- 17000.8.5 After pre-commissioning tests have been completed, the control system will be given a final 90-day performance test.
- 17000.8.6 ACCEPTANCE: For the purpose of this project, the following conditions shall be fulfilled before the WORK is considered substantially complete:
- A. All submittals have been completed and approved.
 - B. The control system has been loop tested and pre-commissioned.
 - C. The OWNER training has been performed.
 - D. Final startup tests have been successfully completed.
 - E. All debris associated with installation of instrumentation has been removed.
 - F. All probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.
- 17000.9 WARRANTY**
- 17000.9.1 The CONTRACTOR shall guarantee the performance and the hardware of all the instrumentation, control, telemetry and SCADA equipment and associated installation, as specified herein, for a period of one (1) year following the date of completion and formal acceptance of the WORK and successful completion of the performance tests.
- 17000.9.2 Equipment, software, programming, installation, and materials which do not achieve design requirements after installation shall be replaced or modified by the CONTRACTOR to attain compliance, at no additional cost to the OWNER. Following replacement or modification, the CONTRACTOR shall retest the system and perform any additional procedures needed to place the complete system in satisfactory operation and attain design compliance approval from the ENGINEER.
- 17000.9.3 All parts, material, labor, travel costs, or other expenses incurred in providing any services pertaining to the scope of work defined for this project during the warranty period shall be covered by the CONTRACTOR under the guarantee.
- 17000.9.4 The complete SCADA system (and associated software) included therein shall be guaranteed to meet or exceed the design requirements set forth in the Contract Documents.

17000.9.5 The CONTRACTOR warrants the materials and workmanship used for the SCADA system equipment and materials furnished under the Contract, and further guarantees the materials and workmanship used for any equipment and materials produced and furnished hereunder as a part of the work of this Contract to be as herein specified and agreed upon, free from injurious defects, and in all respects satisfactory for the service required.

17000.9.6 The CONTRACTOR shall warrant/guarantee the satisfactory performance of the equipment and materials under operating conditions. In the event that tests and inspections disclose latent defects or failure to meet the specified requirements, the CONTRACTOR upon notification by the ENGINEER shall proceed at once to correct or repair any such defects or non-conformance or to furnish, at the delivery point named in the Contract, such new equipment or parts as may be necessary for conformity to the specified requirements, and shall receive no additional compensation.

17000.9.7 The CONTRACTOR shall guarantee that the completed system shall perform all of the data acquisition, control, and reporting functions as shown and specified.

17000.10 MATERIALS

17000.10.1 All materials and equipment furnished under this contract shall be new, free from defects, and shall be standard products produced by manufacturers regularly engaged in the manufacture of these products. No products shall be provided that have been discontinued or marked as "End of Life" by the manufacturer.

17000.10.2 Where there is more than one item of similar equipment being furnished under this contract, all such similar equipment shall be the product of a singular manufacturer.

17000.10.3 All meters, instruments, and other components shall be the most recent field proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise specified to match existing equipment.

17000.10.4 SIGNAL LEVELS:

- A. Analog measurements and control signals shall be as indicated herein, and unless otherwise indicated, shall vary in direct linear proportion to the measured variable.
- B. Electrical analog signals outside control panels shall be 4 to 20 mA DC.
- C. All electric signals shall be electrically or optically isolated from other signals.
- D. Discrete input signal shall be 24VDC, unless otherwise noted. Use of 120 VAC for discrete inputs is not permitted.
- E. Discrete output signals shall be:
 - 1. 24VDC dry contact with interposing relays, unless otherwise noted.
 - 2. Pilot lights within RTU's may be 24 VDC and driven by 24 VDC discrete.
 - 3. All discrete outputs without exception shall be routed through an external terminal block and clearly marked as external voltage.

17000.10.5 All instrumentation and equipment shall be suitable for operation in ambient conditions at the equipment installation locations. Special considerations and approval must be provided for equipment installed in locations where the environment can exceed the manufacturer recommendations.

17000.11 SOURCE QUALITY CONTROL

17000.11.1 The CONTRACTOR shall arrange with all Manufacturers of the equipment and fabricators of panels and cabinets, supplied under this project to allow the OWNER and ENGINEER to inspect and witness the testing of the equipment at the site of fabrication.

- A. Equipment shall include the cabinets, special control systems, flow measuring devices, and other pertinent systems and devices.
- B. A minimum of 15 working days notification shall be provided to the ENGINEER prior to testing.
- C. No shipments shall be made without the ENGINEER'S approval before completion of testing.

17000.11.2 **FACTORY ACCEPTANCE TESTS (FAT):** Prior to shipment, the complete control system including all MTUs, RTUs, PLCs, LCPs, peripherals, communications equipment, and other equipment, shall be assembled, connected, and all software and programming loaded for a full functional test of the integrated system.

- A. Test procedures shall be developed and submitted by the CONTRACTOR to show that the integrated system hardware and software is fully operational and in compliance with the requirements of the Contract Documents.
- B. All hardware test procedures shall follow the guidelines of the applicable portions of Sections 3 through 8 in ISA's recommended practice ANSI/ ISA RP.1-1975(R1983).
- C. A copy of the test procedures shall be submitted to the ENGINEER in conformance with Section 17000.5 of this section.
- D. The factory test will be witnessed by the OWNER and ENGINEER.
- E. The factory test shall make use of hardware simulators that contain switches, pilot lights, variable analog signal generators, and analog signal level displays, that shall be connected to the I/O points within the control system. All inputs and outputs shall be simulated and proper control system operation shall be validated. Each switch, pilot light, display, etc. shall be labeled in accordance with the P&ID'S so that a timely and thorough test of the complete system can be conducted.
- F. Test Procedures
 - 1. PLC I/O Test:
 - a. Test shall be conducted prior to the arrival of the OWNER and ENGINEER for the witness FAT.
 - b. ENGINEER and OWNER shall review the test checklists.
 - c. ENGINEER and OWNER shall at random pick points to be tested.
 - d. If any of the randomly selected points fail the test, the point will be noted for future troubleshooting. It is up to the discretion of the ENGINEER and OWNER to determine if a re-test will be required once the corrections have been made. All costs for the re-test,

- including engineer's and owner's time and travel expenses shall be by the CONTRACTOR.
- e. A PLC I/O Test Checklist Form must be created and filled out during testing to document that all PLC I/O has been properly tested. This form should contain information on the control panel, PLC type, and persons involved in testing. For each PLC or I/O gateway, the following should be tested:
 - i. **Discrete inputs:** Apply appropriate input and panel terminal, observe input card indicator, observe data value at each indicated data address on site OIT or local display.
 - ii. **Discrete outputs:** Toggle bit in output buffer, observe data point, output card indicator light and measure response at field wiring terminals.
 - iii. **Analog inputs:** Apply appropriate analog input signal at panel terminals, observe data value at each indicated data address on site OIT or local display. Simulated sensor inputs corresponding to 0, 10, 50, 90 and 100% of span shall be applied, and the resulting element outputs monitored to verify compliance to calculated network accuracy tolerance requirements.
 - iv. **Analog outputs:** Enter scaled values in the output data address, observe the output data value, and measure appropriate response at panel wiring terminals.
2. Factory Acceptance Test:
- a. ENGINEER and OWNER shall witness factory test.
 - b. The items tested will follow and be documented in the FAT procedures that were approved during submittals. These items will include but are not limited to:
 - i. Verify correct and secure mounting of all equipment inside the control panel.
 - ii. Verify that the constructed panel or equipment matches the approved drawings.
 - iii. Verify that all equipment power on and that all voltages are within specified ranges.
 - iv. Test any solar or battery charging circuits.
 - v. Test scaling functions of all analog inputs.
 - vi. Simulate equipment process operation to ensure that programming meets control requirements.
 - vii. Verify that all programmed test modes work as expected.
 - viii. Test all necessary alarms including but not limited to:
 - 1. Process high and low level.
 - 2. Analog signal out of range.
 - 3. Inter-site communication fail.
 - 4. Pump / valve fail.
 - 5. Discrete process alarms.
 - ix. Test complete functionality of OIT or local displays including but not limited to:
 - 1. Process overview screens
 - 2. Screen and page navigation
 - 3. User security and accessibility
 - 4. Operator adjustable setpoints

17000.12 INSTALLATION

17000.12.1 It is the responsibility of the CONTRACTOR to ensure that all equipment added, modified, or relocated be:

- A. Installed.
- B. Connected
- C. Tested.
- D. Started to place the system in operation.

i. This shall include final calibration in concert with equipment specified elsewhere in these Contract Documents.

17000.12.2 It is the intent of these specifications that the CONTRACTOR shall accomplish the physical installation of all elements, instruments, accessories or assemblies specified in these contract documents.

- A. The CONTRACTOR shall employ installers who are skilled and experienced in the installation and connection of all elements, instruments, accessories and assemblies.
- B. Electrical work shall be performed as specified in the applicable sections of Division 16.

17000.12.3 The monitoring and control system configurations are diagrammatic. The locations of equipment are approximate unless dimensioned. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. Where job conditions require reasonable changes in approximated locations and arrangements, the INTEGRATOR shall make such changes without extra cost to the OWNER, in accordance with the requirements of Division 16.

17000.12.4 All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. The OWNER reserves the right to require minor changes in location of equipment prior to roughing in without incurring any additional costs or charges.

17000.12.5 CONDUIT, CABLES, AND FIELD WIRING. All conduits shall be provided under Division 16 without delay to the WORK of Division 17. All 4-20 mA signal circuits, process equipment control wiring, signal wiring to field instruments, PLC input and output wiring and other field wiring and cables shall be provided under Division 16. All SCADA System equipment cables, and process communication networks shall be provided under Division 17. All terminations and wire identification at control system equipment furnished under this or any other Division shall be provided as identified in Section 16.

- A. Cables or wires that are specified to carry AC signal or power shall not be run in the same conduit as cables or wires specified to carry DC signal or power. These current types must be run in separate conduits. The same applies to raceways or wire trays except where a separator is installed.

17000.12.6 COMMUNICATIONS CABLES.

- A. Ethernet: Communications cables that will be used for Ethernet connectivity will meet Category 6 specifications as per EIA/TIA 568A. All Ethernet patch cables are to meet Category 6 specifications as well. In spaces with common air the cable needs to be plenum rated.

- B. Video: Camera cabling will be RG6 coax with 95% copper braid. In spaces with common air the cable needs to be plenum rated. Power conductors can be included within the jacket covering.

17000.12.7 EQUIPMENT TIE-DOWNS. All instruments, control panels, and equipment shall be anchored by methods which comply with seismic and wind bracing requirements which apply to the site. All control panels, VCPs, LCPs, etc., must be permanently mounted and tied down to structures.

17000.12.8 The ENGINEER has based the drawings and design on preliminary information furnished by various equipment manufacturers. It is incumbent on the part of the CONTRACTOR to include in the bid all material and labor needed to install the actual equipment furnished.

- A. The instrument equipment specifications, ladder logic diagrams, and installation details are based on non-certified vendor information and indicate minimum scope of supply from the equipment manufacturer.
- B. The System Supplier shall include all costs in its bid to add additional instruments, wiring, input/output modules, control devices, conduit, interlocks, electrical hardware, etc., into the design based on the equipment manufacturer's final certified vendor drawings.
 - i. Such changes to instrumentation and electrical work shall be incorporated into the scope of work at no additional cost to the OWNER in light of the contractor's knowledge that non-certified vendor information has been used in the design.
- C. The CONTRACTOR shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements.
- D. All such additions and all such changes, including the proposed method of installation, shall be submitted to the ENGINEER for approval prior to commencing the work.
- E. Such changes shall not be a basis of claims for extra work or delay.

17000.12.9 INSTALLATION CRITERIA AND VALIDATION. CONTRACTOR shall verify that all control panels, enclosures, instrumentation, conduit, wire, and all other equipment are installed correctly and according to the requirements below:

- A. Installation personnel have been instructed on installation requirements of the Contract Documents.
- B. All flexible cables and capillary tubing shall be installed in ridged or flexible conduits. The lengths shall be sufficient to withdraw the element for periodic maintenance.
- C. All power and signal wires shall be properly terminated.
- D. All conduit connectors and fittings shall be watertight.
- E. All wires shall be clearly marked with permanent identifiers that refer back to control panel drawings or other record drawings.
- F. All wire and cable shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically approved by the ENGINEER. All wiring shall be protected from sharp edges and corners.

- G. All mounting stands and bracket materials and workmanship shall comply with requirements of the Contract Documents.
- H. Verify the correctness of each installation, including polarity of electric power and signal connections, and making sure all process connections are free of leaks. The System Supplier shall certify in writing that for each loop or system, all discrepancies have been corrected.

17000.13 FIELD QUALITY CONTROL

17000.13.1 LOOP VALIDATION. All instruments, devices, valves, and systems shall be verified and adjusted after installation, in conformance with the component manufacturer's instructions.

- A. Loop Validation Test. Each instrument shall be field verified and/or calibrated by the CONTRACTOR.
 - 1. Each instrument or process value shall be tested from the signal source to each monitoring or control device. The output from the instrument shall be verified at the associated PLC register, OIT display, and HMI screen, if applicable. The value shall be observed to read and be displayed correctly at each device including scale, range, and units. All control elements shall also be tested by manipulating the control value at the PLC, OIT, local hand controls, and HMI screen, if applicable.
 - 2. Instrument and Instrument Component Validation: Each instrument shall be field tested, inspected, and adjusted to its indicated performance requirement in accordance with Manufacturer's specifications and instructions.
 - 3. Any instrument which fails to meet any Contract requirement, or, in the absence of a Contract requirement, any published manufacturer performance specification for functional and operational parameters, shall be recalibrated, repaired, or replaced at the discretion of the ENGINEER at no additional cost to the OWNER.
- B. All control loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the SCADA System. Actual signals shall be used wherever available.
- C. Following any necessary corrections, the loops shall be retested.

17000.13.2 Individual component accuracy requirements shall be as indicated by Contract requirements or by published manufacturer accuracy specifications, whenever Contract accuracy requirements are not indicated.

- A. Each analog network shall be tested by applying simulated analog or discrete inputs to the first element of an analog network.
- B. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discrete devices.
- C. Provisional settings shall be made on controllers and alarms during analog loop tests.

- D. All analog loop test data shall be recorded on test forms which include calculated network system accuracy tolerance requirements for each output.
- E. Each field device requiring an analog output shall be exercised through the control system. During this validation process the output from the PLC shall be varied and the end device position, speed, etc. shall be measured to confirm the proper operation of the device for the supplied analog signal from the control system.
- F. Each field device providing a discrete input to the control system shall be exercised in the field and the proper operation shall be observed at the control system.
 - 1. Limit switches shall be tested and limits set mechanically and then proper operation shall be observed as reported to the control system.
 - 2. Starters, relay contacts, switch contacts shall be exercised and proper operation shall be observed as reported to the control system.
 - 3. Instrument supplying discrete inputs to the control system shall be calibrated and tested, and the proper operation shall be observed as reported to the control system.
- G. Each field device accepting a discrete output signal from the control system shall be exercised in the field and proper operation shall be confirmed by correlating the control system signal with the actual response in the field.
 - 1. Valves shall be stroked through outputs from the control system and proper directional operation shall be field confirmed, as well as limits, and reports back to the control system.
 - 2. Motors starters shall be exercised from the control system and proper operation verified through direct field observation.
 - 3. Solenoids and other field devices shall be exercised from the control system and proper operation verified through direct field observation.
- H. Instrument validation sheets shall be completed for each and every field instrument and/or analyzer that provide the following information and a space for sign-off on individual items and on the completed unit:
 - 1. Project name.
 - 2. Loop number.
 - 3. Tag number.
 - 4. Manufacturer.
 - 5. Model number.
 - 6. Serial number.
 - 7. Analog input devices:
 - a. Calibrated range
 - b. Analog input associated PLC register address.
 - c. Value in PLC register at 0, 10%, 50%, 90% and 100% of span.
 - d. Value in SCADA database at 0, 10%, 50%, 90% and 100% of span.
 - 8. Analog output devices:
 - a. Calibration range.
 - b. Analog output associated PLC register address.
 - c. Control variable value at field device at 0, 10%, 50%, 90% and 100% of span.
 - d. Physical device response 0, 10%, 50%, 90% and 100% of span.
Response to be actual valve position, or motor speed, etc.
 - 9. Discrete instrument input devices:

- a. Switch setting, contact action, and dead band.
 - b. Valve position switches:
 - 1) Response in the PLC as the valve is stroked from the PLC.
 - 2) Field observed actual valve position, and valve indicator position as the valve is stroked from the PLC.
 - c. Operator interface switches and associated response.
 - d. Starter and drive auxiliary device contact response.
 - e. Response of all other discrete inputs to the PLC.
10. Discrete output devices:
Documented observed response of field device to the discrete output from the PLC.
Observe the proper operation of Open, Close, Start, Stop, On, Off, etc.
11. Utilize the Factory Acceptance Test, PLC I/O Test form format modified to become the Loop Validation Test Checklist.
12. Space for sign-off by INTEGRATOR and date.
13. Test equipment used and associated serial numbers.

17000.13.3 PRE-COMMISSIONING TEST.

- A. General. Pre-commissioning test shall commence as specified in paragraph 17000.8 of this Section. Pre-commissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
- B. Pre-commissioning Procedures and Documentation. All pre-commissioning and test activities shall follow detailed test procedures and check lists accepted by the ENGINEER. All test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the ENGINEER, which include calculated tolerance limits for each step. Completion of all system pre-commissioning and test activities shall be documented by a certified report, including all test forms with test data entered, delivered to the ENGINEER with a clear and unequivocal statement that all system pre-commissioning and test requirements have been satisfied.
- C. Operational Validation. Where feasible, system pre-commissioning activities shall include the use of water or air as applicable to establish service conditions that simulate, to the greatest extent possible the normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. All hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic control circuits. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.
- D. Loop Tuning. All electronic control stations incorporating proportional, integral or derivative control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response.

- E. If excessive oscillations or system instability, as determined by the ENGINEER, occur the INTEGRATOR, in conjunction with the ENGINEER, shall develop and implement any additional control algorithms needed to achieve an optimal control loop operation, at no additional cost to the OWNER.
- F. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 0, 10, 50, 90 and 100% of span and the results checked against indicated accuracy tolerances.
- G. Pre-commissioning Validation Sheets. Pre-commissioning shall be documented on one of two types of test forms as follows:
 - 1. For functions which can be demonstrated on a loop-by-loop basis, the form shall include:
 - a. Project name.
 - b. Loop number.
 - c. Loop description.
 - d. Tag number, description, manufacturer and data sheet number for each component.
 - e. Space for sign-off and date by both the INTEGRATOR and ENGINEER.
 - f. Use the FAT Loop Test Checklist forms modified to meet these specific testing conditions.
 - 2. For functions which cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:
 - a. Specification page and paragraph of function demonstrated.
 - b. Description of function.
 - c. Space for sign-off and date by both INTEGRATOR and ENGINEER.
 - d. Use the FAT Loop Test Checklist forms modified to meet these specific testing conditions.
- H. Functional Performance
 - 1. General. The complete control system including all SCADA screens, reports, trends, etc. shall be functional throughout the pre-commissioning test. The complete control system shall perform all specified functions within the time frames listed below, based on the ultimate system expansion. Tests or calculations shall be developed to extrapolate from the initial system measured performance to the expanded system performance.
 - 2. Data Update Times. Data received from RTUs shall be displayed on the operator's console within 1 second of receipt of such data at the workstation, regardless of originating RTU, state of the data received, and the number of stations that require the data. Alarm printouts, when required, shall be initiated within the same 1 second time frame.
 - 3. Screen Displays. Any specified screen display, except trend displays, shall be drawn complete on any furnished CRT, including all real-time data, within 3 seconds from an operator request for the displays.
 - 4. Trend Displays. Any specified trend display containing up to three trend lines and any time interval, both real-time and historical, shall be drawn complete on any furnished CRT within 10 seconds from an operator request for the trend display.
 - 5. Reports. Any specified report shall be compiled and printing initiated on any furnished printer within 30 seconds from an operator request for the report.

- I. Pre-commissioning Certification. The CONTRACTOR shall submit an instrumentation and control system pre-commissioning completion report which shall state that all Contract requirements have been met and shall include a listing of all instrumentation and control system maintenance and repair activities conducted during the pre-commissioning testing.
- 17000.13.4 PROOF OF CONFORMANCE. The burden of proof of conformance to specified accuracy and performance is on the CONTRACTOR. The CONTRACTOR shall supply necessary test equipment and technical personnel if called upon to prove accuracy and/or performance, at no separate additional cost to the OWNER, wherever reasonable doubt or evidence of malfunction or poor performance may appear.
- 17000.13.5 TESTING. All systems shall be exercised through functional and operational tests in the presence of the owner's representative in order to demonstrate achievement of the specified performance. Operational tests depend upon completion of work specified elsewhere in these Contract Documents. The scheduling of tests shall be coordinated by the CONTRACTOR among all parties involved so that the tests may proceed without delays or disruption by uncompleted work.
- 17000.13.6 ADJUSTING. At no separate additional cost to the OWNER, the CONTRACTOR shall include the following services of qualified technical representative.
- A. Make all necessary adjustments, calibrations and tests.
- B. Control Valves: All control valves, cylinders, drives and connecting linkages shall be stroked from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and positioner settings shall be checked with the valves in place to insure that no changes have occurred since the bench calibration.
- 17000.13.7 CLEANING. All control panels and enclosures shall be vacuumed clean prior to start-up and again after final completion of the project. All panel surfaces shall be cleaned, any scratches and/or defects shall be repaired to "new" condition. If in the engineer's opinion the panel repairs do not constitute "new" condition, they shall be replaced with new panels at no additional cost to the OWNER.
- A. All instrument faces and enclosures shall be wiped and/or vacuumed clean.
- B. Removal of Abandoned Equipment: All existing instrumentation and control equipment that is no longer required after the new system has been put into service shall be removed and delivered to the OWNER by the CONTRACTOR, except where specified in the Contract Documents.
- 17000.13.8 DEMONSTRATION
- A. Performance Test. After successful completion of the pre-commissioning test as accepted by the ENGINEER and OWNER, the performance test and system startup by the OWNER'S operating personnel shall follow.
- B. The performance test is part of the work that must be completed as a condition of substantial completion for the entire project. The complete PLC control and SCADA system must run continuously for the duration of the performance test. During this period, all system functions shall be exercised, and any system interruption and accompanying component, subsystem, or program failure shall be logged for cause of

failure, as well as time of occurrence and duration of each failure. The INTEGRATOR shall provide a competently trained technician or programmer on call for the project site during all normal working days and hours from the start of the performance test until final acceptance of the system. Response time to the project site shall be within 24 hours of a major failure.

- C. Process Control System Testing. The entire process control system shall be tested and used under standard operating conditions.
- D. SCADA System Testing. The systems to be tested on-line will include the visualization programs, reporting programs, alarm notification software, and remote access.
 - 1. Each system function, e.g., status report, alarms, logs, and displays shall be exercised several times at a minimum, and in a manner which approximates "normal" system operation.
 - 2. Failure of the system during the above program testing shall be considered as indicating that the programs and operating system do not meet the requirements of the specifications and corrective action shall be required before restarting the acceptance test.
 - 3. Only those components, sub-systems, and systems covered in this specification and supplied under this contract shall be considered for this acceptance test.
 - 4. Problems and failures of other systems shall not be considered as part of this test, except as they display the capabilities of this system to detect failures.
- E. Failures. Failures shall be classified as either major or minor.
 - 1. A minor failure would be a small and non-critical component failure or software problem which can be corrected by the owner's operators. This occurrence shall be logged but shall not be reason enough for stopping the test and shall not be grounds for non-acceptance. Should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance. Failure of one instrument, indicator, or operation shall be considered a minor failure providing all functions can be provided by backup equipment, and repairs can be made and equipment returned to service within 3 working days.
 - 2. A major failure shall be considered to have occurred when a component, subsystem, software control, or program fault causes a halt in or improper operation of the system and/or when a technician's work is required to make a repair or to re-initiate operation of the system.
 - a. A major failure shall cause termination of the performance test.
 - b. When the causes of a major failure have been corrected, a new acceptance test shall be started.
 - c. Failure of a control loop to maintain stability or function properly resulting in a process disturbance.
 - d. Failure of any control system that results in an overflow, underflow, overdose, or underdose condition shall be considered as a major failure.
- F. Technician Report. Each time a technician is required to respond to a system malfunction he or she must complete a report which shall include details concerning the nature of the complaint or malfunction and the resulting repair action required and taken.
 - 1. If a malfunction occurs which clears itself or which the operator on duty is able to correct, no report shall be required or logged as specified above.
 - 2. If a technician has performed work but no report is written, then a major failure shall be considered to have occurred.

3. Each report shall be submitted within 24 hours to the ENGINEER or its representative, and the OWNER.

17000.14 TRAINING

17000.14.1 GENERAL: The CONTRACTOR shall provide system maintenance and operator training courses by a qualified instructor for all the instrumentation, control, and computer monitoring and control systems furnished for this project.

- A. All instruction training material shall be provided by CONTRACTOR.
- B. One of the individuals conducting the course must be the same individual responsible for the majority of the programming that was performed for the instrumentation and control system.

17000.14.2 SCHEDULE: In conformance with the requirements of paragraph 17000.8 Sequencing and Scheduling of this Section.

17000.14.3 Agenda: The training shall include standard operation procedures, regular maintenance procedures, basic troubleshooting techniques, changing operational and alarming set-points, and calibration for that specific piece of equipment.

17000.14.4 Maintenance/Operator Training. A maintenance/operator training course shall be provided for up to eight (8) designated personnel and representatives of the OWNER.

- A. This course shall be designed to provide the operations, maintenance and supervisory personnel with training in routine and preventive maintenance of all items in the instrumentation, control and the computer monitoring and control systems.
- B. The training course shall include instruction on the use of all maintenance equipment provided under Section 17.
- C. During the course, hands-on experience with the system equipment shall be provided. Training for specific site-installed equipment shall be performed in person on-site.
- D. Course duration: The training course shall be long enough to provide all attendees with sufficient exposure to the equipment and procedures, and to provide ample time for answering attendees' questions. Course time will vary based on the complexity of the site. Estimated course time will be reviewed during the training itinerary submittal, however, training must be scheduled for a minimum of 2 hours per remote site and a minimum of 3 hours per HMI training.
- E. Training topics for a remote site include but are not limited to:
 1. Introduction to the site, process overview
 2. Overview of major controls equipment and instrumentation
 3. Standard operation and control description
 4. Emergency operation and any other non-standard operation
 5. OIT operation.
 - a. Page overviews.
 - b. Changing setpoints.
 - c. Page security.
 6. Troubleshooting.

- a. Power.
 - b. Communications.
 - c. Major equipment.
 - d. Instrumentation.
 - 7. Maintenance.
 - 8. Questions.
- F. Training topics for an HMI deployment or upgrade include but are not limited to:
- 1. Introduction of HMI software package.
 - 2. User access and login credentials.
 - a. Remote access.
 - 3. Standard monitoring and control.
 - 4. User security, logs, access rights.
 - 5. Viewing historical data and trends.
 - 6. Report generation.
 - 7. Alarm notification.
 - a. Alarm pipelines.
 - b. Notification rosters.
 - c. Callout contact information.
 - 8. Equipment or software maintenance.
 - 9. Questions.

17000.15 PROJECT DOCUMENTATION AND RECORD DRAWINGS

- 17000.15.1 GENERAL: The CONTRACTOR shall provide all final project documentation and record drawings. Final versions of these documents are required before final acceptance of the project will be allowed.
- 17000.15.2 SHOP DRAWINGS: Final shop drawings shall be provided with all corrections in accordance with Section 17100 – Instrumentation Control Panels – General.
- 17000.15.3 OPERATIONS AND MAINTENANCE MANUAL: A final Operations and Maintenance Manual shall be provided for all sites and equipment included in the project scope. Required topics include but are not limited to:
- A. System overview.
 - B. System communication architecture and description of communication methods.
 - C. Individual site information.
 - 1. Site description.
 - 2. Site communication.
 - 3. Site control description.
 - 4. Description of all equipment used including:
 - a. Manufacturer.
 - b. Manufacturer's part number.
 - c. Equipment data sheet or owner's manual.
 - 5. RTU or manufactured panel final shop drawings.
 - 6. OIT keymaps or navigation instructions.
 - D. HMI training resources.
 - E. Recommended maintenance.
 - F. Basic troubleshooting guide.
 - G. All completed testing and startup verification forms.

17000.15.4 DOCUMENT DISTRIBUTION:

- A. Operations and Maintenance Manual.
 - 1. Two (2) copies of the Operations and Maintenance Manual shall be provided to the OWNER. Manuals shall be printed on plain 8.5 by 11 inch white paper. Manuals shall be bound using a 3-ring binder with each section marked with tabbed dividers.
 - a. Any shop drawings or other documents that are scaled to a larger page size shall be printed on the corresponding page size and folded to fit within the 8.5 by 11 inch page footprint.
 - 2. A digital copy of the Operations and Maintenance Manual shall be provided to the OWNER via a project USB memory stick furnished by the CONTRACTOR.
- B. Shop Drawings.
 - 1. A copy of each shop drawing shall be printed and provided in the Operations and Maintenance Manual. A separate printed copy shall also be placed in each control panel in accordance with Section 17100 – Instrumentation Control Panels – General.
 - 2. A digital copy of each shop drawing shall be provided to the OWNER via a project USB memory stick furnished by the CONTRACTOR.

17000.1.1 CONTROL SYSTEMS AND SCADA

System controls and SCADA integration will be supplied and performed by OWNER'S designated Integrator. OWNER'S INTEGRATOR shall be contracted directly by CONTRACTOR and shall be included in this contract. INTEGRATOR shall be Advanced Process Control & Optimization (APCO), no substitutions.

CONTRACTOR shall verify all electrical control conduits, conductors, instrumentation, and control panel mounting with INTEGRATOR before installation.

17050.1 SUMMARY

- A. This Section includes:
 - 1. General control strategies that shall apply to all control schemes.
 - 2. For specific control strategies as they apply to the specific control loops of this project see Section 17050SP if applicable.

- B. Related Sections:
 - 1. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

17050.2 COMMON CONTROL FUNCTIONS

- A. Common control functions are common to all control loops and devices and shall be incorporated into the control schemes for all devices.
 - 1. Common control schemes are identified on the P&IDs and basic representations are reflected in the control schematics. Complete control loops and the individual loop descriptions and may not be shown on the P&IDs.
 - 2. By nature of the fact that these are common control functions they shall be incorporated into all control strategies, whether they are shown and/or described or not.

- B. Common control functions are as follows:
 - 1. Alarm fail condition, unless otherwise specified, shall be logically derived under and of the following conditions:
 - a) Device is commanded to start, and the auxiliary current switch does not echo the command.
 - b) Device is commanded to stop, and the auxiliary current switch does not echo the command.
 - c) Device is commanded to open, and the open limit switch does not echo the opened condition in two times the normal full travel time.
 - d) Device is commanded to close, and the close limit switch does not echo the closed condition in two times the normal full travel time.
 - 2. Motor winding temperature switches, unless otherwise specified, shall only alarm a high temperature condition and not stop the motor.
 - 3. Motor overload switches shall always stop the motor, by de-energizing the motor starter.
 - 4. Equipment runtime and start counts shall be determined through an auxiliary current switch which is an input to the PLC.
 - a) Elapsed run time and starts shall be displayed at the SCADA level for each and every motor or engine controlled through the PLC system.
 - b) Individual runtime and starts accumulation shall be reset by the operator after entering a password if the proper security level is associated with said password.
 - c) Runtime shall be displayed as 99,999.9 hours after which the elapsed run time registers shall recycle to 0.0 hours. Starts shall be displayed as 999,999 starts after which elapsed starts registers shall recycle to 0 starts.
 - d) Provisions shall be made to allow the operator to enter a start value for runtime and starts accumulation.
 - e) Runtime and starts shall be calculated and stored in PLC registers. This data is transmitted to the SCADA HMI for historization.
 - f) Equipment start counts shall be incremented when the equipment run status transitions from Off to On.

5. Equipment run status shall be determined through a current switch mounted to one of the motor power leads, after all breakers, contactors, and overloads. If this is not possible, a status through an auxiliary contact on the starter is sufficient as an alternate.
6. For every motor or engine controlled by the PLC, an equipment spindown timer shall be added as a permissive to the start command. After the equipment is de-energized, this spindown timer shall prevent a start command until the completion of the timer. This shall prevent excessive and unwanted equipment cycling. Spindown timer is to be operator adjustable.
7. PID control algorithms.
 - a) Each PID control algorithm shall have a face plate associated with the individual PID control algorithm that shall be displayed at its associated HMI and at the OIT. Said face plate shall have the following functions:
 - (1) Display Output, CV.
 - (2) Display Setpoint, SP.
 - (3) Display Process Variable, PV.
 - (4) Allow for operator selection of Automatic or Manual control of Output.
 - (5) Under manual control of output allow the Operator to enter the desired output value.
 - (6) Allow for input of the three PID tuning parameters.
8. Each panel, designated by a RTU or MTU number, shall contain a PLC and an OIT unless otherwise shown on the drawings. The OIT shall be used as the primary interface for entering parameters particular to the operation of the site.
 - a) A main menu screen shall be developed that will allow the operator to view main process information that is critical for site operation.
 - b) There shall be a screen for each individual system within the panel that displays:
 - (1) Tank or process level.
 - (2) Line pressure.
 - (3) Flow rate and flow total.
 - (4) Equipment runtimes and starts.
 - (5) Site information such as site intrusion, power status, generator status, and ambient temperature.
 - (6) All system alarms, active or not.
 - (7) Inter-site or inter-device communication status.
 - (8) Others as needed and directed by the ENGINEER.
 - c) Standard system operator adjustable setpoints shall include but are not limited to:
 - (1) Tank high and low levels
 - (2) Line pressure high and low setpoints with corresponding latched alarms and latch resets.
 - (3) Flow rate high and low setpoints.
 - (4) Others as needed and directed by the ENGINEER.
9. System security: The system shall be protected with a series of security layers. These layers may apply to the OIT as well as HMI.
 - a) Guest: User is logged in by default. View only privileges.
 - b) Operator: User must log in with credentials to gain Operator security level. Authenticated users can change operational setpoints such as equipment start and stop setpoint as well as manual operational control. User can also acknowledge active alarms.
 - c) Supervisor: User must log in with credentials to gain Supervisor security level. Authenticated users have all privileges of Operator security level as well as change alarm setpoints.

- d) Administrator: User must log in with credentials to gain Administrator security level. Authenticated users have all available privileges in the system including adjusting scaling, communication settings, and user account information.
10. Status indication:
- a) The associated pilot light, OIT display, and HMI display for each valve and pump shall indicate valve position by constantly illuminating the corresponding status indication and report this condition to the HMI system.
 - b) All site alarms shall flash the associated status indicator and alarm within the SCADA system.
 - c) When a valve is in transition, not fully closed and not fully opened, then the valve open and valve closed status indicator shall:
 - (1) For HMI and graphic displays state that the valve is in transition.
 - (2) For pilot lights shall not illuminate the valve fully opened or fully closed pilot lights.
11. The manual control mode shall be completely manual and under operator control, there shall be no programmed interlocks requiring completion of a previous step before operating a device, unless specifically identified in the individual loop descriptions as occurring in the manual mode.
- C. Alarm/Fault Indication/Acknowledgment
- 1. Furnish an alarm acknowledgment HMI pushbutton function at each alarm shown as active in the HMI.
 - 2. In general any alarm condition shall flash the appropriate graphic symbol and generate an audible alarm.
 - 3. The individual alarm acknowledgment action shall function as follows:
 - a) Shall change the flashing alarm indication to continuously ON if the alarm or fail condition persists after the acknowledgment action has been depressed.
 - b) Shall change the alarm indication to a more neutral color if the alarm condition has been corrected but has not been acknowledged.
 - c) Shall turn OFF the alarm indication if the alarm or fail condition has been corrected and the alarming system has returned to normal.
 - 4. An alarm silence HMI pushbutton command shall silence an audible alarm but continue to show the visual alarm.
 - 5. All valves, pumps, motors, and other process equipment shall have fail alarms displayed and reported at the OIT and HMI level.
 - 6. Any alarm that is not acknowledged after a setpoint period of time shall activate the alarm notification system. Alarms can be sent out to operators using email, SMS messaging, or voice phone calls.
- D. Tank and vessel levels.
- 1. All tank and vessel levels shall be displayed both in feet (XX.XX) and gallons, whether or not specifically identified in the P&IDs or Loop descriptions.
 - 2. All identified tanks and/or vessels that have a level measurement shall include, whether or not identified, the following minimum functions that shall be displayed on the associated HMI and SCADA System.
 - a) Numerical readout of process material level in the tank.
 - b) Numerical readout of process material volume in the tank.
 - c) Setpoint for high level and high level alarm.
 - d) Setpoint for low level and low level alarm.
 - e) Setpoints for high level and low level shall be entered as a level or volume as directed by the ENGINEER and shall be fully adjustable by operators at the OIT or HMI that have proper authentication.

- E. Power failure.
 - 1. The control system upon sensing a power failure shall store, within, the PLC memory the current status of all devices, ie. ON or OFF.
 - 2. Upon restoration of power the control system shall then sequence ON all equipment that was running prior to the power failure condition.
 - 3. PLCs operating from UPS or backup battery power shall monitor utility power status and differentiate between true alarm conditions and alarm conditions caused by power failure.
 - a) Conditions which are to be expected during power loss (ex. fail to run, open or close and some fail-safe equipment fault alarms) shall not be initiated due to loss of power, except for specific power loss alarms.
 - b) Other alarms (such as high and low level alarms) shall continue to function during power loss conditions.
 - c) A Power Loss Alarm shall be sent to the alarm notification system.
- F. PLC System Status.
 - 1. There shall be a minimum of one HMI screen that shall show the status of all PLCs in the system including inter-site communication status.

17050.3 FORMAT

- A. Organization.
 - 1. Displays shall be organized such that the operator shall be able to quickly determine the main process status of the sites. Supplementary or detailed information should be displayed upon further navigation.
 - 2. Display navigation shall be apparent to the operator by use of tabbed menus or navigation icons such as arrows.
 - 3. All alarms, active or not, shall be visible from a central alarms page. For HMI displays, each site may have a separate alarms page.
- B. Colors: Where color displays are available, the following colors shall be reserved and only used for the following purposes:
 - 1. Red: Alarms – Active, Unacknowledged or Active, Acknowledged.
 - 2. Dark Green: Alarms – Cleared, Unacknowledged.
 - 3. Bright Green: Equipment run status on.

SPECIAL PROVISION

**NORTH LOGAN RATTLESNAKE HILL TANK
PERFORMANCE REQUIREMENT**

**SECTION
17051SP**

17051.1 DESCRIPTION

This section identifies system performance requirements for system operation of the new Rattlesnake Hill Tank and PRV vault. CONTRACTOR is responsible for ensuring that all requirements are met.

17051.1.1 RELATED WORK

Section 17000 – Instrumentation and Controls - General
Section 17100 – Instrumentation Control Panels, General Requirements

17051.2 CONSTRUCTION INSTALLATION AND INTEGRATION REQUIREMENTS

17051.2.1 All process values shown in P&ID’s included the Contract Documents shall be available for monitoring using existing remote SCADA software.

17051.2.2 CONTRACTOR is responsible for supply, construction, and installation of all required RTU panels, instrumentation, and all required communications equipment, including modems, antenna conduits, antennas, masts, and appurtenances required for the SCADA system. Integration requirements and system functions are listed in the table in 17051.3 below.

17051.2.3 INTEGRATOR is responsible for ensuring appropriate safeguards are deployed for the safety of installed equipment, operations personnel, and proper operation of the well system.

17051.2.4 INTEGRATOR is responsible for ensuring stable communication between new remote sites and existing SCADA architecture. Integrator shall submit recommendation for communication method prior to construction in accordance with section 17000. If radio or cellular communications are recommended, a radio path or cellular reception survey shall be conducted to ensure sufficient communications.

17051.2.5 All telemetry equipment provided by CONTRACTOR, including but not limited to instrumentation, PLC, operator interface, communication equipment, and RTU components, shall be of similar type and model as used in other remote sites operated by OWNER.

17051.2.6 All programming, calibration, and integration shall be of equal or greater quality as work previously performed for OWNER at other remote sites.

17051.3 REQUIRED SCADA SYSTEM ALARM, INDICATION, AND CONTROL FUNCTIONS

17051.3.1 The following tables outline system requirements for equipment, communication, automation, remote monitoring, and remote control for each site.

Rattlesnake Hill Tank	
Performance Requirements:	
	A new submersible level transducer shall be supplied and installed in the new water tank.
	New High and Low Level float switches shall be supplied and installed in the new water tank.
	High Level float switch shall be mounted 1’ below tank overflow and shall generate a High Level alarm when tipped.
	Low Level float switch shall be mounted 15’ from tank floor and shall generate a Low Level alarm when un-tipped.
	Tank Fill Valve Actuator shall be controlled by the RTU. Valve operation shall be based on tank level. When the tank level reaches below the tank fill start setpoint, the valve shall open. The valve shall close when the tank level reaches the tank fill top setpoint.

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	Tank Fill Valve Actuator shall be provided with a battery backup to allow for failsafe movement in the event of a loss of power. The failsafe for the actuator shall be configured to close during a power failure.
	Flow meters shall be monitored via industrial communication protocol. Instantaneous flow rate and flow total shall be recorded.
	In-line pressure transducer shall be supplied and installed on the discharge line of the water tank.
	Magnetic intrusion sensors shall be supplied and installed at each tank hatch and at the bunker door. These shall be monitored and shall generate an alarm if intrusion is detected.
	Ambient air temperature inside the bunker shall be monitored. An alarm shall be generated if the ambient air temperature drops below the setpoint for the bunker heater.
	Chlorine Analyzer shall be supplied and installed to monitor effluent chlorine levels from the tank.
	All control setpoints, scaling setpoints, alarm setpoints, and control actions shall be operator-adjustable via local operator interface or remote SCADA software.

Existing Well 5	
Performance Requirements:	
	Control programming and functionality shall be added to the existing Well 5. During standard system operation, Well 5 operates to maintain tank level in the Green Canyon Tanks. If the system is in isolation mode, Well 5 will need to operate to maintain the Rattlesnake Hill tank level. When in isolation mode, the Rattlesnake Hill RTU will need to communicate with Well 5 and Well 5 will operate in tandem with the Rattlesnake Hill Tank Fill Valve. Control programming shall be added to the Well 5 controller to allow operators to switch between the standard and isolation control modes.

PRV Vault	
Performance Requirements:	
	Pressure transducers shall be supplied and installed for both the inlet and outlet of the PRV. High and Low level alarms shall be generated based on independent setpoints for each transducer.
	Full open and full closed positions on each PRV shall be monitored via the RTU.
	PRV settings shall be changed manually. No remote control shall be required for operation.
	Ambient air temperature inside the vault shall be monitored. An alarm shall be generated if the ambient air temperature drops below the setpoint for the vault heater.
	All control setpoints, scaling setpoints, alarm setpoints, and control actions shall be operator-adjustable via local operator interface or remote SCADA software.

HMI/SCADA Server	
Performance Requirements:	
	All monitored process values shown in P&ID and values listed in specifications shall be transmitted to the existing central HMI/SCADA Server.
	Existing HMI/SCADA Server shall be upgraded as needed to support addition of new remote sites.
	All costs of additional hardware or software upgrades required for integration of new remote sites shall be included in the cost of this project.

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17051.4 METHOD OF MEASUREMENT

17051.4.1 INSTRUMENTATION & CONTROL INSTALLATION

Provide all components required in enclosures; mounted, wired, and acceptable testing installed in their final location. All communications equipment installed and in working condition. Provide, install and wire any field instrumentation specified. Any other appurtenances as required, and as shown on the Drawings and as defined in the applicable sections of the Specifications required for a complete and fully functioning system.

17051.5 BASIS OF PAYMENT

17051.5.1 No separate payment shall be made for furnishing or installing control systems, components, or materials required to be installed within the pay limits for a building or enclosure identified in the BID schedule to be furnished by the INTEGRATOR.

17051.5.2 When control systems, components, or materials are measured for a new or existing building or enclosure as shown on the Bid Schedule, separate payment will be made as listed below.

<u>PAY ITEM</u>	<u>UNIT</u>
<i>(Site) SCADA System</i>	Lump Sum

17051.5.3 Partial payments for Lump Sum items shall be made for furnishing or installing control systems, components, or materials in accordance with the payment schedule table below.

<u>Payment</u>	<u>Amount</u>	<u>Paid When</u>
1 st	50% of Lump Sum Item	RTU or other Equipment is mounted, wired, and accepted in their final location.
2 nd	25% of Lump Sum Item	Site specific RTU has communication with remote monitoring system.
3 rd (Final)	25% of Lump Sum Item	Site Specific SCADA System is fully functioning in its final state and accepted by Engineer and Owner.

Note: 5% will be retained from each of the payment milestones listed above, until Substantial Completion in accordance with the Agreement.

17100.1 GENERAL

17100.1.1 SUMMARY

- A. This section sets the general specifications and requirements for all the control panels and enclosures being provided under this contract.
 - 1. Included but not limited to all custom built and designed control panels including RTU's, MTU's, communication panels, or terminal breakout panels.
 - 2. The CONTRACTOR shall furnish, supply and install all custom control panels for this project in accordance with CONTRACT documents.
 - 3. This section also covers requirements for local control panels being supplied by the Equipment Manufacturers as part of the packaged equipment.

- B. RELATED SECTIONS
 - 1. The contract Documents are a single integrated document, and as such Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to ensure a complete and coordinated project.
 - 2. This section shall be used in conjunction with the following specification sections:
 - a. General Electrical Requirements – Section 16010.
 - b. Instrumentation & Control, General – Section 17000.
 - c. Instrumentation & Control, General-Instrument List – Section 17000SP.

17100.1.2 SYSTEM DESCRIPTION

- A. Scope: The Electrical & Controls Contractors shall furnish the following custom control panels:
 - 1. See Section 17100SP for Instrumentation Control Panels, General - Panel List

- B. General requirements that apply to all control panels.
 - 1. The supply voltage within the control panel controls shall be 120 VAC. Where the electrical power supply to the control panel is 240 VAC single phase or 480 VAC 3-Phase, as shown on the electrical drawings, the control panel shall be provided with a control power transformer.
 - 2. Source power for control panels.
 - a. All control panels shall be supplied with a maximum of 120 VAC, 60 Hz. power.
 - b. Supply all transformers, protection, and power supplies needed to convert the supply voltage of 120 VAC to the needed utilization voltage within each control panel.
 - c. The panel must have a nameplate identifying this circuit breaker feeding the panel and a warning statement requiring that the feeder beaker be turned off before opening the door to the enclosure.

3. Enclosure general requirements.
 - a. Control panels shall have enclosures that meet the area classifications as specified on the drawings.
 - b. For those areas not specified:
 - 1) Control panels installed outdoors or in a security enclosure shall be housed in NEMA 12 enclosures.
 - 2) Control panels installed outdoors shall be housed in NEMA 4 enclosures.
 - 3) Control panels installed within chemical rooms, 10 miles of ocean coast, or other known corrosive or hazardous environments shall be housed in NEMA 4X enclosures.
 - c. Control panels shall be either freestanding, wall-mounted, pedestal-mounted, or equipment skid-mounted, as specified or shown.
 - d. Internal control components shall be mounted on an internal back-panel.
 - 1) Control components shall be mounted to painted steel or aluminum back-panels. Unpainted steel or wood back-panels are not allowed.
 - 2) Devices may be mounted on the side-panel only by special permission from the ENGINEER.
4. Each source of foreign voltage shall be clearly labeled on the front of the enclosure. No voltage sources greater than 240 VAC shall be allowed to enter the control panel. Any equipment such as motor starters that utilize greater voltage shall be located in a separate enclosure.
5. Motor starters, where required, shall be provided to meet the requirements specified in Section 16150, "Electrical Control Devices".
6. Discrete outputs from the control panel shall be provided by electrically isolated contacts rated for 5 amps at the required voltage. Contact closure shall be achieved through the use of an interposing relay associated with the PLC.
7. Analog inputs and outputs shall be an isolated 4-20 mA 2-wire signal.
8. All control panel mounted operator interface devices shall be mounted between:
 - a. A minimum of 3 feet above finished floor elevation.
 - b. A maximum of 6 feet above finished floor elevation.

17100.1.3 SUBMITTALS

- A. In accordance with Section 17000.5 Process Control & Instrumentation General Requirements.
- B. Control Panel Engineering Submittals: Complete manufacturable shop drawings shall be submitted for each control panel that is to be provided. Details shall be submitted for each component included in the control panel. These submittals may be provided separately or in conjunction with other Instrumentation and Controls submittals.
 1. Control Panel Hardware submittal that shall include but not be limited to:
 - a. Enclosure construction details and NEMA type.
 - b. Finish, including color chart for ENGINEER selection of color.
 - c. Layout.
 - d. Power circuits.
 - e. Signal and safety grounding circuits.

- f. Fuses.
- g. Circuit breakers.
- h. Signal circuits.
- i. Internally mounted instrumentation.
- j. PLC's.
- k. Systems Integrator components.
- l. Face plate mounted instrumentation components.
- m. Internal panel arrangements.
- n. External panel arrangements.
- o. Construction drawings drawn to scale that define and quantify:
 - 1) The type and gauge of fabrication steel to be used for panel fabrication.
 - 2) Panel door locks and hinge mechanisms.
 - 3) Type of bolts and bolt locations for section joining and anchoring.
 - 4) Details on the utilization of mounting equipment such as "UNISTRUT" and proposed locations.
 - 5) Electrical terminal box and outlet locations.
 - 6) Electrical access locations.
 - 7) Print pocket locations.
- p. A bill of material that enumerates all devices associated with the control panel.
- q. A listing of spare parts as specified in the drawings.

17100.1.4 SHOP DRAWINGS

A. General

- 1. Each control panel, motor control panel, communications panel, or any other manufactured panel that contains controls equipment and wiring shall be accompanied by appropriate shop drawings.
- 2. Drawings shall be submitted to the ENGINEER for review before manufacturing in accordance with Section 17000 of the Contract Documents.
- 3. All shop drawings shall be scaled to fit on standard 11 inch by 17 inch paper.

B. Drawing Requirements:

- 1. Drawings shall be produced using professional drafting software and shall meet current electrical control panel design standards and industry best practices. Each shop drawing shall include the following information or sections:
 - a. Title page
 - b. Title block containing the following information:
 - 1) Name and address of company producing the drawing.
 - 2) Project number and name.
 - 3) Drawing number.
 - 4) Panel description.
 - 5) Revision number.
 - 6) Drawing date.
 - 7) Engineer who produced the drawing.
 - 8) Engineer who reviewed the drawing.
 - c. Legend.
 - d. Bill of materials including identification number, manufacturer, manufacturer part number, and quantity.
 - e. Enclosure details including dimensions, mounting information, and nameplate data. Front, side, and plan views shall be shown to scale.
 - f. Mechanical layout including dimensions, position of equipment, mounting conditions, and identification of all components. Mechanical layout must also meet all clearances, mounting requirements, and other recommendations by the manufacturer.

- g. Electrical wiring:
 - 1) Power distribution.
 - 2) Communication.
 - 3) I/O wiring, I/O labeling, and loop diagrams
 - 4) Controls wiring including all terminal strip, terminal block, and relay numbering.
 - 5) Field wiring designating instrument type and terminal number for each wire that is to be connected to the device.
- 2. Enclosure details and mechanical layouts shall be drawn to scale.
- 3. Includes all numbering for wires, terminal blocks, and other equipment used.
- 4. All PLCs shall be shown with their current I/O allocation, future I/O allocation, spares provided under this project, and the maximum potential I/O based on available slots.
- 5. Each wire or cable shown on the shop drawings shall have a unique wire identifying number. This same number shall be printed on heat shrink label and secured to each end of the wire or cable during construction and installation.
- 6. Includes information on all cabling required to support communication requirements such as ethernet cables, serial cables, and factory-provided cables. Serial cable pinouts shall also be shown.
- C. As-Builts
 - 1. At the completion of manufacturing, testing, installation, and commissioning, all edits, changes, or markups to the shop drawings approved during submittals shall be incorporated into the shop drawings and the drawings shall be published as an as-built revision.
 - 2. A copy of the as-built drawings for each control panel shall be printed on standard 11x17 paper, stapled, folded, and included inside the installed control panel.
 - a. If the enclosure does not contain a document pouch, the drawings shall be inserted into the panel in a location that does not interfere with access or operation of the equipment.
 - b. For smaller panels and junction boxes, the drawings may be adhered to the inside of the door of the panel.
 - 3. Additional hard copies of each as-built drawing shall be included in the project user manual per Section 17000 of the Contract Documents.
 - 4. All drawings developed for this project shall be provided to the owner in .pdf digital format.

17100.1.5 QUALITY ASSURANCE

- A. All indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents.
- B. Heating, cooling, and dehumidifying devices shall be provided in order to maintain all instrumentation devices to within a range equal to 20% above the minimum and 20% below the maximum of the rated environmental operating ranges.
- C. Provide all power wiring for these devices.
- D. Enclosures suitable for the environment shall be furnished.
- E. Mounting location of all electrical equipment shall have proper spacing to account for manufacturer's recommendations pertaining to physical operation constraints, heat dissipation, or other safety requirements.

- F. All instrumentation in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed. This includes all “Intrinsically Safe” equipment and required spacing.
- G. All control panels and assemblies shall be labeled and listed by a nationally recognized testing laboratory.
 - 1. UL 508A or approved equal.

17100.1.6 DELIVERY, STORAGE AND HANDLING

- A. All panels are to be crated for shipment using a heavy framework and protective materials. The panel sections shall further be cushioned satisfactorily to protect the finish of the instruments and panel during shipment. All instruments that are shipped with the panel shall further have suitable shipping protection and cushioning material installed in a manner to protect instrument parts that could be damaged due to mechanical shock during shipment. Each separate panel unit shall be provided with removable lifting lugs or other handling aides where required.

17100.1.7 WARRANTY

All equipment in control panels shall be under warranty for a period of one year from the date of completion of the control system start up.

17100.2 EQUIPMENT

17100.2.1 ENCLOSURE

- A. ENCLOSURE REQUIREMENTS – All enclosures housing controls equipment must meet the following requirements. The NEMA rating is based on the environmental conditions where the enclosure is to be mounted.
 - 1. NEMA 12
 - a. Enclosure designed to house electrical controls, terminals, and instruments, providing protection from:
 - 1) Dust
 - 2) Dirt.
 - 3) Oil.
 - 4) Water.
 - b. Seams continuously welded and ground smooth.
 - c. Door and body stiffeners as needed to make a rigid enclosure.
 - d. Heavy gauge continuous hinge.
 - e. Rolled lip around three sides of the door and all sides of the enclosure opening to prevent migration of liquids and contaminants into enclosure.
 - f. Oil-resistant gasket attached to door with oil-resistant adhesive. Gasket to seal against roll lip on the enclosure opening.
 - g. Internal mounting panel held in place by collar studs welded to enclosure.
 - h. Door window when shown on the drawings.
 - 1) Safety plate glass.
 - 2) Held in place by rubber locking seal.

- 3) To allow full view of numeric display, PLC I/O, LED display, and keyboard, etc.
 - i. Panel cutouts for instruments, devices, and windows shall be cut, punched, or drilled and smoothly finished with rounded edges. Cutout quantity, size, and location not to exceed manufacturer's recommendations.
 - j. Finish.
 - 1) Interior, smooth, white polyester powder coating.
 - 2) Exterior polyester powder coating color to be determined by ENGINEER.
 - 3) Exterior brushed stainless for stainless steel panels.
 - k. Manufacturer's standard gauge steel.
 - l. Each door is to have a three-point minimum latching mechanism. Enclosure door or any access ports must be able to be secured via removable padlock.
 - m. With print pocket inside door.
 - n. Conform to:
 - 1) NEMA Type 12.
 - 2) JIC EGP-1-1967.
 - 3) JIC EMP-1-1967.
 - 4) U.L. Listed.
 - o. Mounting panel to match manufacturer's recommendation for size, thickness, edge bends, and stiffeners.
- 2. NEMA 4
 - a. Enclosure shall meet all applicable requirements for NEMA 12 with the additional requirements listed below. Enclosure designed to house electrical controls, terminals, and instruments, providing protection from:
 - 1) Dust
 - 2) Dirt.
 - 3) Oil.
 - 4) Water.
 - b. Enclosure is labeled as "wash-down rated" and is more resistant to prolonged exposure to moisture.
 - c. Reinforced oil-resistant gasket with additional or reinforced locking clasps.
- 3. NEMA 4X
 - a. Enclosure shall meet all applicable requirements for NEMA 4 with the additional requirements listed below. Enclosure designed to house electrical controls, terminals, and instruments, providing protection from:
 - 1) Dust.
 - 2) Dirt.
 - 3) Oil.
 - 4) Water.
 - 5) Caustic or corrosive environments.
 - b. Accepted materials include:
 - 1) Stainless Steel.
 - 2) Fiberglass.
 - 3) Aluminum.
 - c. Oil resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
 - d. All seams sealed.

- e. Hinges fiberglass with no exposed metal parts.
- f. Only exposed metal parts are to be stainless steel.
- g. Provisions for mounting panels must be an integral part of the enclosure whether by way of internal mounting channels welded to the interior or by way of spot-welded collar studs.
- h. Mounting panels to be constructed of aluminum plate.
- i. Panel finish.
 - 1) Gray exterior.
 - 2) White interior.
 - 3) White enamel aluminum mounting plate.

B. BACK-PANEL REQUIREMENTS

- 1. Standard manufactured enclosure and back-panel shall be used, whenever possible.
- 2. Back-panel should have the same manufacturer. Acceptable back-panel materials are painted steel and aluminum. Unpainted steel or wood panels are not allowed.
- 3. All components should be mounted securely to internal back-panels using machine screws into drilled and tapped holes. Self-tapping screws are not allowed.
- 4. Devices may be mounted on the side of the enclosure only by special permission from the ENGINEER.

C. DEAD-FRONT

- 1. Where specified, a dead-front can be used to isolate operator controls, such as OIT, control switches, and indicators, from other equipment inside the enclosure.
- 2. Dead-front shall be compatible with enclosure manufacturer.

D. VENTILATION AND OTHER ENVIRONMENTAL CONDITIONING

- 1. If required, enclosure may be fitted with supplementary ventilation or environmental conditioning such as heating, cooling, and dehumidification.
- 2. Any alterations in support of ventilation or environmental conditioning shall not jeopardize the NEMA rating of the enclosure.

E. MANUFACTURERS

- 1. Approved enclosure and back-panel manufacturers include:
 - a. Hoffman Engineering.
 - b. Approved Equal.

F. INSTALLATION

- 1. Enclosures shall be installed by a competent and trained installer. It is the responsibility of the CONTRACTOR to ensure that the enclosure is installed correctly including the use of correct mounting hardware, conduit penetration locations, and mounting location for access to operator controls.
- 2. Penetrations for conduit, instrumentation, or other purposes shall be made in accordance to the following:
 - a. Penetrations shall be made in the bottom of the enclosure wherever possible.
 - b. If necessary, penetrations may be allowed on the side of the enclosure, but shall be kept in the bottom half, if possible.
 - c. Penetrations into the top of the enclosure are not allowed.
- 3. Mounting Location
 - a. Enclosure shall be mounted in accordance with the Contract Drawings. The Contractor shall ensure the following:

- 1) Enclosure shall be mounted in a location that is easily accessible to operations and maintenance personnel.
- 2) Enclosure door shall not be obstructed by any object or other constraint from opening fully to access equipment.
- 3) If operations controls such as OIT, control switches, or indicators are included with the control panel, enclosure shall be mounted such that interactive equipment is accessible from a standing position.

17100.2.2 POWER SUPPLY

A. REQUIREMENTS

1. Power supply to convert panel 120 VAC source power to DC control power.
2. Provide adjustable output power voltage range to support panel power requirements.
3. Shall be sized 20% higher than maximum anticipated power requirements.
 - a. In accordance with Section 17005.5.1 of the Contract Documents, power calculations shall be submitted to prove sufficient power supply.
4. DIN-Rail mountable.
5. Spring-clamp or screw terminal connections.

B. MANUFACTURERS

1. Approved power supply models include:
 - a. Allen-Bradley 1606-XLS Series.
 - b. Approved Equal.

17100.2.3 BATTERY BACKUP

A. REQUIREMENTS

1. Control panel is to have sufficient backup battery power to continue standard operations for a minimum of 24 hours.
 - a. In accordance with Section 17005.5.1 of the Contract Documents, power calculations shall be submitted to prove sufficient power storage.
2. Battery backup system shall be able to fully recharge battery storage using control power main power source within 72 hours of power restoration.
3. Battery backup system shall utilize external, non-proprietary batteries for ease of procurement and replacement.
4. Shall provide sufficient fuses, breakers, or disconnects to isolate batteries for maintenance and replacement.

B. MANUFACTURERS

1. Approved battery charger manufacturers include:
 - a. Phoenix Contact.
 - b. Victron Energy.
 - c. Approved Equal.

17100.2.4 PROGRAMMABLE LOGIC CONTROLLER

A. REQUIREMENTS

1. Each PLC that is to be used shall adhere to the following:
2. Support modern programming languages such as:
 - a. Ladder Logic.
 - b. Function Block.
 - c. Structured Text.
3. Temperature and environmental specification shall meet or exceed the anticipated environment where the control panel is to be installed without the use of supplementary environmental conditioning.
 - a. Environmental conditioning may be installed to reduce strain and prolong the life expectancy of equipment but shall not be relied upon for normal operation.
 - b. Environmental conditioning may be relied upon for normal functioning of equipment only by special permission from the ENGINEER.
4. PLC programming shall adhere to programming requirements in Section 17050 – Control Strategies, General.
5. PLC and PLC I/O expansion modules shall be sized such to provide a minimum of 20% spare for each input type:
 - a. Analog Input.
 - b. Analog Output.
 - c. Digital Input.
 - d. Digital Output.

B. MANUFACTURERS

1. Approved PLC manufacturers include:
 - a. Schneider Electric.
 - b. Allen-Bradley.
 - c. Approved Equal.

17100.2.5 OPERATOR INTERFACE TERMINAL

A. REQUIREMENTS

1. Each control panel that provides process monitoring or control shall contain a local OIT for operator monitoring and control.
2. OIT can be either:
 - a. LCD screen with 4 or more lines.
 - b. Color touch screen.
3. Screen shall be of sufficient size to easily convey site information.
4. Operators shall have the ability to monitor and control all major site processes.
5. OIT programming shall adhere to programming requirements in Section 17050 – Control Strategies, General.
6. In locations where OIT is not in constant use, power saving functions shall be deployed to preserve screen life and power consumption.
 - a. If power saving functions are not available, OIT power shall be controlled by the PLC using a relay.
 - 1) OIT power shuts off after a timed delay.
 - 2) Power is restored by pressing “OIT Enable” pushbutton located next to OIT.
 - 3) OIT power can also be controlled through a control panel door intrusion switch.

7. OIT screen shall be easily visible in environment where it will be installed. Use of sunshades or other aides are allowed.
8. Manufacturer environmental specifications shall meet or exceed expected environmental conditions without use of supplemental environmental conditioning.

B. MANUFACTURERS

1. Approved OIT manufacturers include:
 - a. Maple Systems.
 - b. Allen-Bradley.
 - c. Approved Equal.

17100.2.6

NETWORK SWITCH

A. REQUIREMENTS

1. Each network switch that it used shall adhere to the following:
2. Temperature and environmental specification shall meet or exceed the anticipated environment where the control panel is to be installed without the use of supplementary environmental conditioning.
3. A managed switch must be provided in locations where communication traffic from certain devices must be managed to allow for uninterrupted communication between critical equipment.
4. Shall be sized to provide two (2) spare ports after all equipment and devices are connected.

B. MANUFACTURERS

1. Approved OIT manufacturers include:
 - a. N-Tron.
 - b. Moxa.
 - c. Antaira.
 - d. Approved Equal.

17100.3

FABRICATION

17100.3.1

GENERAL

A. MOUNTING OF EQUIPMENT AND INSTRUMENTS:

1. Provide cut-outs and mount all instrument items shown or specified to be panel mounted including any instruments specified to be furnished by other vendors but installed in panel (if applicable).
2. Spare space shall be kept clear of wiring, etc., to give maximum space for future additions.
3. Devices or equipment may be mounted on the side of the enclosure only by special permission from the ENGINEER.
4. All electronics, DIN rail, wire trays, mounting brackets, and other equipment shall be attached to the back-panel using machine screws in drilled and tapped holes. Self-tapping screws or adhesives are not allowed.

B. ELECTRICAL REQUIREMENTS

1. Each wire originating from outside the control panel shall be connected to a terminal block. Direct connections of wires originating outside the control panel to control panel equipment are not allowed.
2. Each terminal block shall have a permanent plastic machine imprinted terminal block identifier that corresponds with shop drawings.
3. All wiring shall be identified with permanent machine imprinted wire markers. These wire identifiers shall correspond with labeling in shop drawings. Each wire shall be labeled at both ends, and at every termination point.
4. Freestanding panels shall be provided with switched fluorescent lights. One light shall be provided for every 4-feet of panel width and shall be mounted inside and at the top of the enclosure.
5. Freestanding panels shall be provided with a 15-amp, 120-volt service outlet circuit in an easily accessible area. The circuit shall be provided with 3-wire, 120-volt, 15-ampere, GFCI duplex receptacles one for every 4 feet of panel width (1 minimum per panel) and spaced evenly along the back-of-panel area.
6. Smaller panels shall be so sized as to adequately dissipate heat generated by equipment mounted in or on the panel. If it is determined that additional ventilation is required, the NEMA rating of the enclosure shall not be compromised with any alterations.
8. Wiring Methods:
 - a. Wiring methods and materials for all panels shall be in accordance with the N.E.C. requirements for General Purpose unless otherwise specified.
 - b. All internal panel wires shall be run inside a plastic wire tray with a cover.
 - c. Distance between terminal block and wire tray shall be no less than 2.5 inches.
 - d. All wire trays shall be sized to hold 20% spare wires for future expansion.
 - e. Any wires run from components on a swing-out panel to components on a back-panel shall be bundled neatly together. All finished bundles shall be zip tied and wrapped in split-loom cable wrap.
 - f. Wires containing VAC shall be run separately from wires containing VDC per UL 508A requirements.
9. Signal and Control Circuit Wiring:
 - a. Wire types and sizes:
 - i. Conductor shall be flexible stranded copper machine tool wire.
 - ii. All wire shall be US listed Type MTW flexible or type SIS and shall be rated up to 600-volts.
 - iii. All internal panel wires shall be No. 18 AWG, minimum.
 - b. Wire Insulation Colors:
 - i. Conductors supplying 120 VAC power inside the panel shall have a black insulation for the ungrounded conductor.
 - ii. 120 VAC grounded circuit conductors shall have white insulation.
 - iii. Foreign voltage conductors shall be clearly identifiable by an insulation color separate from any other wire insulation color in the panel.
 1. Foreign voltage conductors are defined as conductors anticipated to carry voltage that originates from a device located outside of the control panel, other than the main power source for the panel. Examples of foreign voltage include source voltage for valves, solenoids, motor start commands, and voltage for status monitoring.

- iv. All other wire insulation colors shall be identified by separate colors. These colors shall correspond to a wire color legend located in the Shop Drawings. These categories may include but are not limited to:
 - 1. 12 VDC supply power.
 - 2. 24 VDC supply power.
 - 3. Common reference.
 - 4. Ground.
 - 5. Switched DC voltage, or signal.
 - c. Fusing
 - i. Each analog input signal shall be fused with a 250 mA AGC fuse. This fuse shall be located at the first terminal block, where the incoming signal wires are first landed in the control panel.
10. Fusing
- a. Supply power for each major equipment shall be individually fused.
 - b. Fuses must be easily removed to safely de-energize equipment.
 - c. Each fuse shall be rated to the maximum current rating for each equipment.
 - d. Each fuse shall be marked with a machine imprinted plastic label with a unique identifier that corresponds to the Shop Drawings. Fuse type and rating shall also be shown on the Shop Drawings.
11. Separation: Efforts shall be made to separate equipment and wiring utilizing 120 VAC from equipment and wiring utilizing DC voltage.
12. Alarm Wiring:
- a. All instrumentation that may be used for alarming shall be wired in the normally closed position such that a loose or disconnected wire will trigger the alarm.
17. Grounding: Furnish equipment ground bus with lugs for connection of all equipment grounding wires.

17100.3.2 SOURCE QUALITY CONTROL

- A. LABOR AND WORKMANSHIP: All panels shall be fabricated, installed and wired by fully qualified workmen who are properly trained, experienced and supervised.
- B. GENERAL: Verification, testing, and instruction shall be provided in accordance with the applicable requirements of Section 17000, "Process Control & Instrumentation General Requirements."

17100.4 EXECUTION

17100.4.1 INSTALLATION

- A. Control panels that are adjacent to motor control centers shall be fully wired to the motor control centers by the CONTRACTOR, using wire ways integral to the motor control center or additional conduits as needed. These interconnections are not shown or reflected on the conduit schedule.

- A. Control panels that are not adjacent to motor control centers shall be fully wired to the motor control centers by the CONTRACTOR. CONTRACTOR shall furnish and install all necessary conduits, junction boxes, and wire between the control panel and MCC based on the contract drawings. CONTRACTOR is responsible to ensure all work and equipment required to achieve full operation is completed and installed.
- B. Field Wiring:
 - 1. All field wires shall have sufficient slack to allow maneuvering of field devices. Field wires shall not be tight as to stretch the wire or exert any stress on termination points.
 - 2. All field wires shall be continuous. No splicing inside conduit or wire raceways is allowed.
 - a. In the event that a factory-provided cable needs to be extended, the wires will be spliced in a junction box using terminal blocks or wire nuts.
 - b. If a factory-provided cable is to be extended, CONTRACTOR is to ensure that wire extension will not hinder calibration, accuracy, or functionality of the instrument or equipment.

17100.4.2 FIELD QUALITY CONTROL

- A. In accordance with Section 17000 Instrumentation & Control, General.
- B. The CONTRACTOR shall install control panels. Termination wiring shall be done in accordance with approved drawings.
- C. All holes for field conduits, etc. shall be cut in the field, there shall be no additional holes or unused factory cut holes. Incorrect holes, additional holes, or miss-cut holes shall require that the entire enclosure be replaced.

17100.4.3 ADJUSTING

All enclosures shall be mounted so that their surfaces are plumb and level to within $\pm 1/16$ " over the entire surface of the panel.

17100.4.4 CLEANING

In accordance with Section 17000 Instrumentation & Control, General.

17100.4.5 DEMONSTRATION

In accordance with Section 17000 Instrumentation & Control, General.

17100.4.6 PROTECTION

Protect all surfaces from damage. Any surface damage or damage to internal components during shipping, installation, or testing shall be repaired and/or replaced as directed by the ENGINEER.

17100.4.7 SCHEDULES

All control panel testing shall be performed prior to shipping.

17310.1 DESCRIPTION

The Contractor shall furnish, test, install, and place into satisfactory operation the submersible pressure transmitter (level transducer) with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

17310.1.1 RELATED WORK

Section 17000 – Instrumentation & Control, General

17310.1.2 SUBMITTALS

The Contractor shall provide descriptive information which indicates the model number, manufacturer's name, dimensions, measuring range and manufacturer's certification of performance in accordance with the requirements of Section 01300.

17310.2 MATERIALS**17310.2.1 SUBMERSIBLE PRESSURE TRANSMITTERS**

1. Device identification: See project drawings.
2. The level transmitter shall be a two-wire type and have an accuracy of 0.25% of full scale, unless noted otherwise in drawings.
3. The transmitter shall produce a 4-20 mA DC signal proportionate to the span range of the transmitter.
4. An integral electrical cable shall be supplied with strain relief that shall have the capability of suspending the transmitter to the proper depth and reaching the local RTU without cable splicing.
5. The cable shall be polyurethane capable of supporting sensor and cable weight with strain relief.
6. Operating range and other specifications as indicated in project drawings.
7. Transmitter should have a sensitivity range above the maximum pressure physically allowable for the application.
8. Measuring element shall use a polymer tube for reference ambient pressure. Polymer tube shall be protected against moisture penetration using attached bellows or drying tube.
9. Electrical Protection: Reverse polarity protection, short circuit protection. Optional lightning protection required if noted in drawings.
10. Manufacturers:
 - a) NOSHOK 613 Series
 - b) Wika Tronic LS-10
 - c) Keller Acculevel
 - d) or approved equal.

17310.3 CONSTRUCTION REQUIREMENTS

The Contractor shall provide all materials needed to install equipment in accordance with the manufacturer's recommendations and at the locations shown on the Drawings.

17310.4 METHOD OF MEASUREMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 17000.

17310.5 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

17315.1 DESCRIPTION

The Contractor shall furnish, test, install, and place into satisfactory operation the liquid level switches with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

17315.1.1 RELATED WORK

Section 17000 – Instrumentation & Control, General

17315.1.2 SUBMITTALS

The Contractor shall provide descriptive information which indicates the model number, manufacturer's name, dimensions, measuring range and manufacturer's certification of performance in accordance with the requirements of Section 01300.

17315.2 MATERIALS**17315.2.1 LIQUID LEVEL SWITCHES**

1. Float actuated switch shall be a dry contact type switch in a hermetically sealed polypropylene casing, suspended on a PVC coated cable.
2. The number of floats per level system shall be as shown.
3. Switch set points shall be as shown on the drawings.
4. Mercury switch type capsules are not allowed.
5. Switch mode (Normally Open or Normally Closed) shall be as indicated in drawings and/or equipment schedules.
6. Factory-provided cable shall be long enough to reach outside of process area and into dedicated junction box.
7. Float shall contain counterweight factory-provided cable.
8. As manufactured by:
 - a) MJK 7030 Series
 - b) or approved equal.

17315.3 CONSTRUCTION REQUIREMENTS

The Contractor shall provide all materials needed to install equipment in accordance with the manufacturer's recommendations and at the locations shown on the Drawings.

17315.4 METHOD OF MEASUREMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 17000.

17315.5 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

17355.1 DESCRIPTION

The CONTRACTOR shall furnish, test, install, and place into satisfactory operation the magnetic door switches with all spare parts, accessories, and appurtenances as specified herein and as shown in the Contract Documents.

17355.1.1 RELATED WORK

Section 17000 – Instrumentation & Control, General

17355.1.2 SUBMITTALS

The CONTRACTOR shall provide descriptive information which indicates the model number, manufacturer's name, dimensions, measuring range and manufacturer's certification of performance in accordance with the requirements of Section 17000.

17355.2 MATERIALS**17355.2.1 MAGNETIC DOOR SWITCHES**

1. All door, tank hatch, or gate position switches shall be of a magnet and reed switch construction unless otherwise shown by contract documents.
2. The number and locations of switches shall be provided on contract documents.
3. Shall be rated to withstand strong forces and heavy traffic.
4. Unless otherwise specified, all door switches used for security purposes shall be wired normally closed.
5. As manufactured by:
 - a) GRI 200/250 Series
 - b) or approved equal.

17355.3 CONSTRUCTION REQUIREMENTS

The CONTRACTOR shall provide all materials needed to install equipment in accordance with the manufacturer's recommendations and at the locations shown on the Drawings.

17355.4 METHOD OF MEASUREMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 17000.

17355.5 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

17361.1 DESCRIPTION

The CONTRACTOR shall furnish, test, install, and place into satisfactory operation the flood switch with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

17361.1.1 RELATED WORK

Section 17000 – Instrumentation & Control, General

17361.1.2 SUBMITTALS

The CONTRACTOR shall provide descriptive information which indicates the model number, manufacturer's name, dimensions, measuring range and manufacturer's certification of performance in accordance with the requirements of Section 01300 of these Specifications.

17361.2 MATERIALS**17361.2.1 FLOOD SWITCH**

1. Device identification: See Section 17000.
2. Float actuated switch shall be mounted with stainless steel mounting bracket.
3. The number of floats shall be as shown.
4. Float shall have no more than 3 inches of travel.
5. Mounted directly to support structure. Floats suspended by cable shall not be accepted.
6. The switch rating shall be at least 0.2 A at 120 VAC and 1A at 24 VDC.
7. Switch mounting location shall be 6" above lowest grade.
8. Wired in normally closed position.
9. Mercury switch type switches are not allowed.
10. As manufactured by:
 - a) Innovative Components BLS-271
 - b) GEMS LS-270
 - c) or approved equal.

17361.3 CONSTRUCTION REQUIREMENTS

The CONTRACTOR shall provide all materials needed to install equipment in accordance with the manufacturer's recommendations and at the locations shown on the Drawings.

17361.4 METHOD OF MEASUREMENT

Separate measurement of this equipment will not be made. Measurement will be included as per Section 17000 of these Specifications.

17361.5 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

17410.1 DESCRIPTION

The Contractor shall furnish, test, install, and place into satisfactory operation the pressure transmitter with all spare parts, accessories, and appurtenances as specified herein and as shown on Contract Drawings.

17410.1.1 RELATED WORK

Section 17000 – Instrumentation & Control General Requirements

17410.1.2 SUBMITTALS

The Contractor shall provide descriptive information which indicates the model number, manufacturer's name, dimensions, measuring range and manufacturer's certification of performance in accordance with the requirements of Section 01300 and Section 17000.

17410.2 MATERIALS**17410.2.1 PRESSURE TRANSMITTER**

1. Device identification: See Contract Documents.
2. Electronic, two-wire type, loop powered, 4-20 mA analog signal output.
3. 316 stainless steel body with stainless wetted parts.
4. Non-indicating transducer.
5. Accuracy including hysteresis, linearity and repeatability shall be within +0.25% of calibrated span.
6. Provide zero, span and dampening adjustments. Zero adjustment shall be external.
7. Operating range and other specifications as stipulated in accordance with contract documents.
8. Manufacturers:
 - a) Viatran
 - b) Ashcroft
 - c) or approved equal.

17410.3 CONSTRUCTION REQUIREMENTS

The Contractor shall provide all materials needed to install equipment in accordance with the manufacturer's recommendations and at the locations shown on the Drawings.

17410.4 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

17420.1 DESCRIPTION

The Contractor shall furnish, test, install, and place into satisfactory operation the ambient air transmitters with all spare parts, accessories, and appurtenances as specified herein and as shown on Contract Drawings.

17420.1.1 RELATED WORK

Section 17000 – Instrumentation & Control General Requirements

17420.1.2 SUBMITTALS

The Contractor shall provide descriptive information which indicates the model number, manufacturer's name, dimensions, measuring range and manufacturer's certification of performance in accordance with the requirements of Section 01300 and Section 17000.

17420.2 MATERIALS**17420.2.1 TEMPERATURE TRANSMITTER**

1. Device identification: See Contract Documents.
2. 4-20 mA analog signal output.
3. DC powered or loop powered.
4. Device shall be sufficiently rated for installation environment.
5. Indicating or non-indicating transmitter.
6. Accuracy including hysteresis, linearity and repeatability shall be within $\pm 0.25\%$ of calibrated span.
7. Provide zero, span and dampening adjustments. Zero adjustment shall be external.
8. Operating range and other specifications as stipulated in accordance with contract documents.
9. Manufacturers:
 - a) Dwyer RHPLC Series
 - b) or approved equal.

17420.3 CONSTRUCTION REQUIREMENTS

The Contractor shall provide all materials needed to install equipment in accordance with the manufacturer's recommendations and at the locations shown on the Drawings.

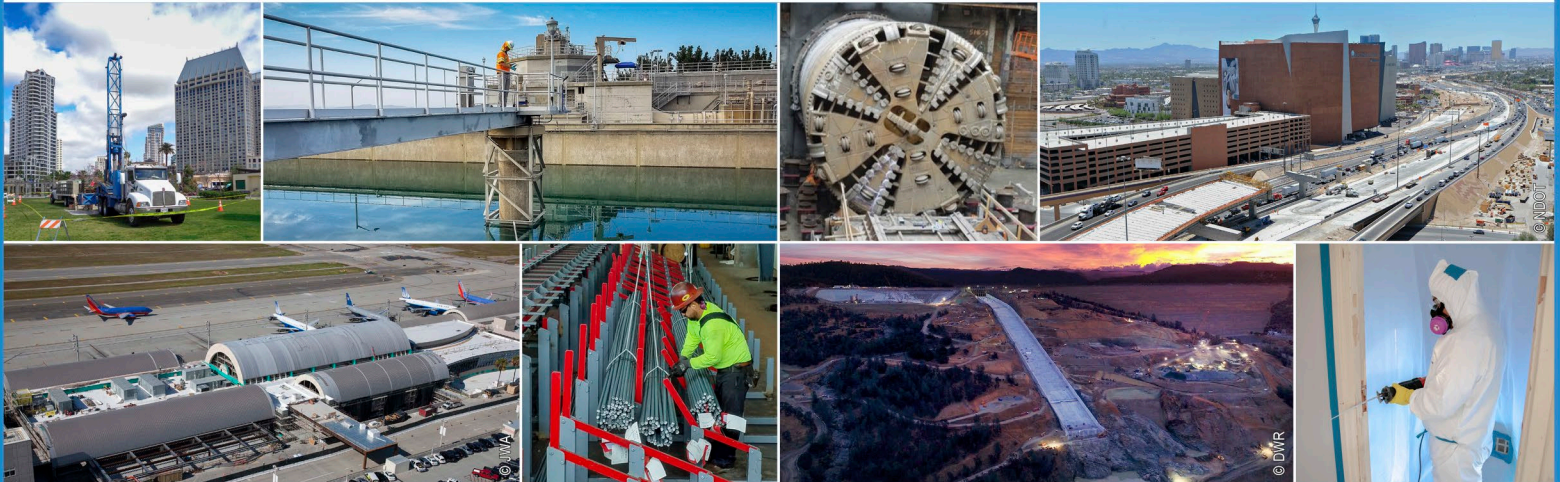
17420.4 BASIS OF PAYMENT

Separate payment for this equipment will not be made.

Geotechnical Evaluation North Logan Water Tank Near 2300 East and Green Canyon Road North Logan, Utah

Sunrise Engineering
2100 North Main | North Logan, Utah 84341

February 17, 2025 | Project No. 800408001



Geotechnical | Environmental | Construction Inspection & Testing | Forensic Engineering & Expert Witness

Geophysics | Engineering Geology | Laboratory Testing | Industrial Hygiene | Occupational Safety | Air Quality | GIS

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

Geotechnical Evaluation

North Logan Water Tank

Near 2300 East and Green Canyon Road
North Logan, Utah

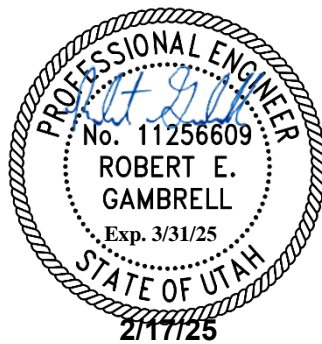
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February 17, 2025 | Project No. 800408001



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1 INTRODUCTION

In accordance with your request, Ninyo & Moore has performed a geotechnical evaluation for the North Logan Water Tank project to be constructed near 2300 East and north of Green Canyon Road in North Logan, Utah. The approximate location of the site is indicated on Figure 1. The purposes of our geotechnical study were to evaluate subsurface soil conditions at the project site and to provide design and construction recommendations regarding geotechnical aspects of the project. This report presents the findings of our subsurface exploration, results of laboratory testing, conclusions regarding subsurface conditions at the project site, and geotechnical recommendations for design and construction of this project.

2 SCOPE OF SERVICES

The scope of our services included the following:

- Review of pertinent background information, including in-house geotechnical data, aerial photographs, published regional and local geologic maps, and soils data.
- Coordination and mobilization for subsurface exploration. Mark-out of existing utilities was conducted through Blue Stakes of Utah.
- Excavating, logging, and photographic documentation of 2 exploratory trenches to depths up to 15 feet. The purpose of the trenches was to evaluate the presence of faults shown on published maps, including the Northern Segment of the East Cache Fault Zone.
- Drilling, logging, and sampling of four exploratory borings to depths up to approximately 72.5 feet. The purpose of the soil borings was to evaluate the subsurface soil and groundwater conditions, including obtaining soil samples for laboratory testing.
- Performance of laboratory tests to evaluate the geotechnical characteristics of the subsurface soils, including in-place moisture content and density, gradation, Atterberg limits (plasticity), consolidation potential, shear strength, and chemical (corrosivity) considerations, including pH, electrical resistivity, water-soluble sulfate content, water-soluble chloride content, and total dissolved solids (solubility).
- Compilation and analysis of the field and laboratory data.
- Preparation of this report presenting our findings, conclusions, and recommendations.

3 PROJECT DESCRIPTION

The project will include design and construction of a new water tank to be located near 2300 East and north of Green Canyon Road near the mouth of Green Canyon on a site that is approximately 13 acres in size. The tank is anticipated to have a capacity of approximately 4 million gallons and will be approximately 30 feet in height, with a diameter of approximately 162 feet. Grading is anticipated to include cuts of up to approximately 55 feet. A portion of the proposed water tank is anticipated to bear approximately 35 feet below the existing grade. Column loads are anticipated on the order of approximately 3,175 pounds per square-foot (psf) for 8-foot square footings. Wall loads are anticipated to be 2,175 psf per linear foot for a 5-foot-wide footing. The tank footings

will be founded on a 4-inch-thick liner slab that is anticipated to have a uniform load of approximately 1,872 psf. Additional site improvements may include concrete flatwork, low-height retaining walls, and paved parking and access areas. The project site is shown on Figure 2.

4 GENERAL SITE CONDITIONS

The project site is located along the margin of Cache Valley and the adjacent foothills of the Bear River Mountains on the eastern edge of the North Logan city limits. At the time of our field activities, the project site was generally undeveloped and primarily covered in native plants and vegetation, including trees on the steep foothills of the Bear River Mountains in the west portion of the site. The topography of the eastern portion of the site slopes gently downward toward the west and northwest. This area appeared to be used previously as agricultural land. The topography of the east portion of the site, which extends into the foothills of the Bear River Mountains, slopes steeply downward to west and northwest. The total relief across the site is approximately 230 feet. Adjacent properties include residential properties to the north, and undeveloped land to the east, west, and south. The adjacent property to the southwest was a previous gravel pit. Three above-ground power transmission lines extend in a north-south direction across the site. Indications of underground utilities were observed at the site, including water lines. Indications of other underground utilities were not observed, but may be present at or near the site.

5 GEOLOGY

Based on our field observations, subsurface exploration, and review of referenced geologic and soils data, the project site is underlain primarily by Quaternary-age alluvial and lacustrine soil deposits (native soil) consisting primarily of silt and clay deposits containing alluvial sand and gravel. Ninyo & Moore's findings regarding the geologic setting, potential geologic hazards, ground motions, and liquefaction potential at the project site are provided in the following sections.

5.1 Geologic Setting

The project site is located in the eastern portion of Cache Valley along the western base of the Bear River Range. The Bear River Range is located on the eastern edge of the Great Basin, which is made up of many naturally formed structural basins resulting from block faulting, which is a fundamental characteristic of the Basin and Range physiographic province.

The Bear River Range was formed during tectonic mountain-building activity known as the Sevier Orogeny 160 to 50 million years (Ma) ago. Compressional tectonic forces resulted in folding and

thrusting of the rocks of the Bear River Range. Normal faulting associated with the Basin and Range extension followed approximately 17 Ma.

Sediment deposition in Cache Valley is largely attributed to the Pleistocene-age Lake Bonneville, a freshwater lake covering much of northern and western Utah and depositing thousands of feet of clay, silt, and sand. After failure of a natural earthen dam on the northern portion of the Lake, water levels dropped over 300 feet rapidly to water levels known as the Provo shoreline. Water levels continued dropping slowly primarily due to drier climate conditions to the modern-day levels of the Great Salt Lake and Utah Lake.

The Bear River Range extends in a north-south direction and generally drains toward the west through rivers and washes into the Bear River. The referenced geologic map titled *Provisional Geologic Map of the Smithfield Quadrangle, Cache County, Utah* (Lowe, M., 1993) indicates that the project area is underlain primarily by Pleistocene-age lacustrine deposits composed primarily of silts and clays containing alluvial sand and gravel deposits.

5.2 Potential Geologic Hazards

Ninyo & Moore's geotechnical study included an evaluation of the possible presence of geologic hazards, such as faults and ground fissures, in the site area. This evaluation included visual observation of the site for indications of adverse geologic features, review of published geologic and soil maps and literature, and other data listed in the references section of this report. Referenced geologic data were also reviewed to evaluate seismic activity levels, and associated potential earthquake hazards, for faults in the site vicinity.

Our review of the referenced study (Hiscock, 2024) indicates that the site is located in a *Fault Trace Mapping and Surface-Fault-Rupture Special Study Zone Delineation of the East and West Cache Fault Zones and Other Regional Faults, Utah*.

Based on our review of referenced data, a fault in the northern segment of the East Cache fault zone traverses the project site. This mapped fault extends roughly parallel to the base of the foothills of the Bear River Mountains in a north-south direction across the central portion of the site. The approximate location of this mapped fault is shown on Figure 2 and Figure 3. Surficial disturbance associated with active faulting was not observed at the site during our field evaluation.

The northern segment of the East Cache fault zone is considered a potentially active normal fault (a fault that has experienced ground surface rupture within the past 1.6 million years). The fault is identified by the USGS as being poorly located due to its poor expression with a slip rate of less

than 0.2 millimeters per year. The USGS description of the East Cache fault zone includes the following:

“Normal fault zone that separates Cache Valley from the Bear River Range to the east. The fault zone is at the boundary between the Basin and Range and the Middle Rocky Mountains physiographic provinces. The East Cache fault zone is one of several north-trending, northeast-stepping, late Quaternary, normal faults that lie between the Wasatch fault zone in Utah and the Teton fault in Wyoming. This fault has 3 sections. McCalpin (1994 #4414) describes physiographic sections because the faulting history cannot be constrained well enough to define seismogenic segments. The sections are differentiated based on fault zone complexity, tectonic geomorphology, and expression of surface fault scarps. The central section of the fault is the most active in the latest Quaternary; the northern and southern sections are less active and show evidence of only middle to late Pleistocene activity.”

Examination of an excavation in 2021 located approximately 0.5 miles north of the site showed evidence of faulting associated with this mapped fault from the northern segment of the East Cache fault zone. Soil samples were collected from either side of the fault and dated using Optical Stimulated Luminescence (OSL) at the Utah State University Luminescence Laboratory in Logan, Utah to determine the deposition age of the soils. Pre- and post-faulting depositional ages were calculated to be approximately 61.53 ± 7.20 and 25.47 ± 2.35 to 24.71 ± 2.22 thousand years ago (ka) respectively. The results show the fault to be considered potentially active and the age category identified by the USGS updated from Quaternary (experienced ground surface rupture within the past 1.6 million years) to late Quaternary (experienced ground surface rupture within the past 130 thousand years).

Review of referenced geologic data indicates that other active faults (i.e., a fault that has experienced ground surface rupture within the past 10,000 years) are located near the site. Table 1 lists the principal, known active and potentially active faults that may affect the project site along with approximate fault-to-site distances and anticipated maximum moment magnitudes (M_{max}). The approximate fault-to-site distances, M_{max} values, and activity levels were obtained using the referenced USGS web-based programs (USGS, 2014; USGS, 2025).

Table 1 – Principal Active Faults in Vicinity of Project Site

Fault Name	Approximate Distance From Project Site to Fault (miles)	Maximum Moment Magnitude (M_{max})
East Cache Fault Zone, Northern Segment (Potentially Active)	Traverses site	7.3
East Cache Fault Zone, Central Segment (Active)	0.3	7.3
West Cache Fault Zone, Junction Hills Segment (Active)	10.5	6.7
West Cache Fault Zone, Wellsville Segment (Active)	12.9	6.6
Wasatch Fault Zone, Collinston Segment (Active)	16.1	--
Wasatch Fault Zone, Brigham City Segment (Active)	16.2	7.0
West Cache Fault Zone, Clarkston Segment (Active)	17.2	6.7

Review of the referenced geologic data and LiDAR imagery does not indicate the presence of ground fissures at the project site and no ground fissures were observed during our field activities.

5.2.1 Fault Trenches

On January 6 and 7, 2025, Ninyo & Moore excavated two fault trenches, FT-1 and FT-2, approximately 215 and 230 feet in length, respectively. These fault trenches were up to approximately 15 feet deep. The purposes of the fault trenches were to locate and evaluate fault(s) from the Northern Segment of the East Cache Fault Zone in relation to the proposed water tank. These fault trenches were also excavated to aid in mapping the location of the fault shown in the referenced USGS (2025) database. The approximate locations of the trenches are shown on Figure 2.

Subsurface conditions observed in the trenches included Quaternary-age alluvium and lacustrine deposits. Exploratory trench logs describing subsurface conditions and other features encountered in the trenches are provided in Appendix A.

Highly organic topsoil was encountered in our fault trenches. Topsoil layers were up to approximately 1.5 feet thick and consisted primarily of very stiff, sandy lean clay with gravel. Below the topsoil, native soil was encountered to the total depths of the trenches. The encountered native soil consisted primarily of medium dense gravel with varying amounts of sand, silt, and clay; medium dense, clayey sand with varying amounts of gravel; and very stiff, sandy lean clay. An alluvial wedge consisting of interbedded layers of poorly graded sand with silt and gravel, silty sand, and sandy clay was observed in the eastern portion of FT-2. The interbedded layers were between 1 and 4 inches thick within the wedge.

Occasional cobbles and boulders up to 4 feet in diameter were encountered in the trenches. The encountered native soils in the trenches were generally moist.

During excavation of FT-2, department heads and faculty of the Utah State University Geology Department with experience in locating the Northern Segment of the East Cache Fault Zone were present to assist in evaluation of conditions encountered in the trenches. LiDAR imagery of the site was reviewed in the field.

Subsurface indications of fault-related movement, including soil deformation, off-set units, or other disturbances were not observed in the trenches. Indications of ground deformation were also not observed. The exploratory trenches were backfilled after excavating.

5.3 Ground Motions

Using the Applied Technology Council (ATC) Hazard Tool (<https://hazards.atcouncil.org>), estimated maximum considered earthquake spectral response accelerations for short (0.2 second) and long (1.0 second) periods were obtained for the project site, which is located at approximately 41.7723 degrees north latitude and -111.7797 degrees west longitude. Based on the results of our field exploration, American Society of Civil Engineers (ASCE) Standard 7-16 (ASCE, 2016), and a review of available geologic information, Seismic Site Class D is appropriate for the project site. The parameters presented in the following table are characteristic of the site for design purposes.

Site Coefficients and Spectral Response Acceleration Parameters	Values
Site Class	D
Site Coefficient at 0.2-second Period, F_a	1.109
Site Coefficient at 1.0-second Period, F_v	1.973
Mapped Spectral Response Acceleration at 0.2-second Period, S_s	0.978g
Mapped Spectral Response Acceleration at 1.0-second Period, S_1	0.327g
Spectral Response Acceleration at 0.2-second Period Adjusted for Site Class, S_{MS}	1.085g
Spectral Response Acceleration at 1.0-second Period Adjusted for Site Class, S_{M1}	0.645g
Design Spectral Response Acceleration at 0.2-second Period, S_{DS}	0.723g
Design Spectral Response Acceleration at 1.0-second Period, S_{D1}	0.430g
Site Amplification Factor, F_{PGA}	1.177
Peak Ground Acceleration, PGA	0.423g
Modified Peak Ground Acceleration, PGA_M	0.498g

5.4 Liquefaction Potential

Liquefaction is a phenomenon in which loose, saturated soils lose shear strength under short-term (dynamic) loading conditions. Ground shaking of sufficient duration results in the loss of grain-to-grain contact in potentially liquefiable soils due to a rapid increase in pore water pressure, causing the soil to behave as a fluid for a short period of time.

To be potentially liquefiable, a soil is typically cohesionless with a grain-size distribution generally consisting of sand and silt. It is generally loose to medium dense and has relatively high moisture content, which is typical near or below groundwater level. The potential for liquefaction decreases with increasing clay and gravel content, but increases as the ground acceleration and duration of shaking increase. Potentially liquefiable soils need to be subjected to sufficient magnitude and duration of ground shaking for liquefaction to occur.

An in-depth evaluation of the potential for liquefaction at the site was outside the scope of this geotechnical evaluation. Review of the referenced geologic data indicates that the project site is mapped in a zone with a low to very low liquefaction potential. In addition, review of referenced hydrogeologic information (Inkenbrandt et al., 2013) indicates that groundwater levels in the vicinity of the site are relatively deep (generally 200 feet deep or deeper). Accordingly, liquefaction is not a design concern.

6 FIELD EXPLORATION AND SUBSURFACE CONDITIONS

Ninyo & Moore's subsurface exploration at the project site was performed from September 26 to October 1, 2024 and January 6 and 7, 2025. This exploration consisted of drilling, logging, and sampling of four exploratory test borings (B-1 through B-4). The borings were drilled with a Diedrich D-50 drill rig utilizing hollow-stem augers. The borings were drilled to depths up to approximately 72.5 feet. The purpose of the borings was to evaluate subsurface conditions at the project site and to collect soil samples for laboratory testing. The elevations of the borings, based on Mean Sea Level (MSL), were estimated from Google Earth (Google Earth Website, 2024) data. Accordingly, the ground elevations that are recorded on the boring logs in Appendix A should be considered approximate. The approximate locations of the borings are shown on Figure 2.

Laboratory tests were performed on representative soil samples collected from the borings to evaluate the in-place moisture content and density, gradation, Atterberg limits (plasticity), consolidation potential, shear strength, and chemical (corrosivity) considerations, including pH, oxidation-reduction potential, electrical resistivity, water-soluble sulfate content, water-soluble chloride content, and total dissolved solids (solubility). The results of the in-place moisture content

and density tests are provided on the boring logs in Appendix A. The other laboratory test results and descriptions of testing procedures utilized are presented in Appendix B and Appendix C.

Two fault trenches were excavated on the north and south sides of the proposed water tank location, transecting the mapped location of the Northern Segment of the East Cache Fault Zone. The trenches were excavated using a Kobelco SK-210 Trackhoe with a 36-inch wide bucket. The purposes of our trenches were to locate and evaluate subsurface conditions in the area of the mapped fault and proposed tank location. The trenches were logged and evaluated by a Ninyo & Moore geologist licensed in Utah. Fault trench locations and the mapped location of the East Cache Fault Zone are shown on Figure 2 and Figure 3. Exploratory trench logs describing subsurface conditions and features are provided in Appendix A.

6.1 Subsurface Soil Encountered

Generalized descriptions of the subsurface soils encountered in the exploratory borings are provided in the following sections. It should be noted that the soil samples were collected using samplers with an inside diameter of approximately 1.4 to 2.4 inches. Accordingly, in-situ soils may have higher concentrations of gravel, cobbles, and/or boulders than indicated on the boring logs.

6.1.1 Topsoil

Topsoil, including highly organic soil with considerable amounts of roots, was encountered in the upper soils of Borings B-1 through B-4 and the fault trench excavations. These surficial soils were between approximately 4 and 18 inches thick.

6.1.2 Native Soil

Native soil was encountered below the topsoil to the total depths of our exploratory borings and excavations. The encountered native soil consisted primarily of medium dense to dense, sand with varying amounts of silt, clay, and gravel; loose to medium dense silt with varying amounts of sand and gravel; stiff to hard, lean clay with varying amounts of sand and gravel; and medium dense to very dense gravel with varying amounts of sand, silt, and clay. The encountered native soils were generally dry to wet.

6.2 Laboratory Testing

Laboratory tests were performed on representative samples of soil obtained from the exploratory borings. Results of these tests are summarized in the following table and presented in Appendix B and Appendix C.

Table 3 – Summary of Laboratory Test Results

Test Type	Test Results	Remarks
In-Place Moisture Content	2.4 to 20.2 percent	--
In-Place Dry Density	45.0 to 124.2 pcf	--
Atterberg Limits		
Liquid Limit	25 to 31	
Plastic Limit	16 to 19	
Plasticity Index	9 to 12	Low plasticity.
Direct Shear		
Peak Cohesion	222 psf	
Peak Friction Angle	31 degrees	--
pH	8.4	--
Electrical Resistivity	18.2 Ohm-m	Severe corrosion potential to normal grade steel.
Water-Soluble Sulfate	<11 mg/kg (ppm)	Sulfate Exposure Class S0 – Negligible corrosion potential to concrete.
Water-Soluble Chloride	30 mg/kg (ppm)	Low corrosion potential to normal grade steel.
Total Dissolved Solids (Solubility)	2,420 mg/kg (ppm)	Low solubility potential.

6.3 Groundwater

Groundwater was not encountered in our borings at the time of drilling. Groundwater levels are influenced by seasonal factors, variations in ground surface topography, precipitation, irrigation practices, soil/rock types, groundwater pumping, and other factors and are subject to fluctuations. Evaluation of factors associated with groundwater fluctuations was beyond the scope of this study.

7 FINDINGS AND CONCLUSIONS

Based on the findings of this study, it is our opinion that there are no known geotechnical or geologic conditions that would preclude construction of the proposed project, provided the recommendations presented herein are implemented and appropriate construction practices are followed. Geotechnical design and construction considerations for the proposed project include the following:

- **Structural Fill and Backfill:** The findings of our study indicate that the soils encountered in our exploratory borings generally should be suitable for use as structural fill and backfill material for the project. The excavated on-site soils may be used as structural fill and backfill provided they comply with the recommendations presented in Section 8.1.2.
- **Topsoil:** Highly organic soil (topsoil) was encountered in the upper approximately 4 inches in our explorations. These upper soils are not appropriate for use as structural fill. Where encountered, topsoil will need to be removed from proposed structure and improvement areas.

- **Subgrade Support:** Structure foundations and other project improvements should be supported on medium dense to very dense native granular soils, on stiff to hard fine-grained native soils, or on properly placed and compacted structural fill (reworked soils or import soils) extending to competent native soils as described above.
- **Groundwater:** Groundwater was not encountered in our exploratory borings at the time of drilling, and is not anticipated to be a design or construction concern.
- **Seismic Parameters:** In accordance with ASCE 7-16, the seismic parameters provided in Table 2 are characteristic of the site and should be considered, where appropriate, in design of the proposed structures.
- **Liquefaction:** The project site is mapped in a zone with a low liquefaction potential. Accordingly, liquefaction is not a design concern.
- **Geologic Hazards:** Review of published geologic data, our field observations, and excavations do not indicate the presence of adverse on-site geologic hazards, such as faults and ground fissures, which may affect proposed site development.
- **Corrosion Potential:** Chemical test results indicate that the tested soils have a low to severe corrosion potential to metal and concrete.
- **Underground Utilities:** Indications of underground utilities were observed at the site during our field activities. Existing utilities at the site should be located and marked prior to earthwork operations, and they should be removed from proposed building and other site improvement areas or abandoned in-place.

8 RECOMMENDATIONS

The following sections provide geotechnical recommendations for design and construction of proposed project improvements.

8.1 Earthwork

The following subsections provide recommendations for earthwork, including site grading, structural fill and backfill, import soil, excavations and dewatering, and temporary excavations and shoring.

8.1.1 Site Grading

Prior to grading, areas of proposed structures and improvements should be cleared of any surface obstructions, pavement, debris, topsoil, vegetation, undocumented fill (if encountered), and other deleterious material. If encountered, existing fill materials should be considered undocumented/non-engineered and unsuitable for support of structures and improvements in the present condition. The term undocumented fill refers to fill placed without engineering control and documentation. Such materials generated from clearing operations should be removed and disposed of in non-structural areas or at a legal landfill. Fill soils may be left in place where documentation can be provided showing that the soils were engineered. Findings of our study indicate that the soils encountered in our exploratory borings generally

should be suitable for use as structural fill and backfill material for the project. Soils excavated in areas of proposed project improvements may be re-used as structural fill and backfill provided they conform to recommendations provided in Section 8.1.2.

After the removals described above have been made, the exposed native soils should be scarified to approximately 6 inches, moisture-conditioned to approximately optimum moisture content, and compacted to 95 percent or more relative compaction, as evaluated by ASTM International (ASTM) Standard D1557. The project's geotechnical consultant should observe excavation bottoms and areas to receive fill at the time of grading to assess the suitability of the exposed material and to evaluate if removals down to more competent soils are needed.

Surface preparations should extend 5 feet or more beyond the exterior edges of planned structure foundations and 2 feet or more beyond planned exterior concrete flatwork, pavement areas, and retaining/screen walls, or to a lateral distance that is equivalent to the depth of compacted structural fill, whichever is greater.

Based on the density/consistency of the existing native soils at the site, some shrinkage should be anticipated when these soils are excavated, processed, and compacted. For planning purposes, an estimated shrinkage factor of approximately 20 percent may be used for on-site soils encountered in the upper 5 feet.

Areas of firm/loose and relatively moist to wet conditions should be anticipated, particularly during the winter and spring months. Unstable and pumping subgrade conditions should be expected during earthwork operations, particularly after rain and snowfall events. Subgrade stabilization will be needed where unstable and pumping subgrade conditions are encountered. Stabilization methods may include the use of geogrids, geofabric, and/or angular rock up to approximately 6 inches in diameter. The geotechnical consultant should evaluate proposed subgrade stabilization methods prior to their implementation.

8.1.2 Structural Fill and Backfill

The following sections include recommendations regarding soil suitability, placement, and compaction of structural fill and backfill.

8.1.2.1 Soil Suitability

Based on the findings of our subsurface evaluation and laboratory test results, the soils encountered during our exploration below the upper organic-rich soils should generally be suitable for use as structural fill and backfill material. The excavated on-site soils may

be used as structural fill and backfill provided they comply with the recommendations presented in this section.

Structural fill and backfill soil should not contain organic matter, debris, other deleterious matter, or rocks or hard chunks larger than approximately 4 inches in nominal diameter. These soils should have a low solubility potential of 1.0 percent or less, as evaluated by SM2540C at an extraction ratio of 1:5 (soil to water) and corrected for dilution, and a very low to low expansion potential/plasticity index (Expansion Index, EI, less than 50, as evaluated by ASTM D4829; or Plasticity Index, PI, less than 15, as evaluated by ASTM D4318).

8.1.2.2 Placement and Compaction

Soils used as structural fill and backfill should be moisture-conditioned to approximately optimum moisture content and placed and compacted in uniform horizontal lifts to a relative compaction of 95 percent, as evaluated by the ASTM D1557. The optimal lift thickness of fill will depend on the type of soil and compaction equipment used, but should generally not exceed approximately 8 inches in loose thickness. Placement and compaction of structural fill should be performed in accordance with applicable building codes.

Earthwork operations should be observed and compaction of structural fill and backfill materials should be tested by the project's geotechnical consultant. Typically, one field test should be performed per lift for each approximately 2,500 square feet of fill placement in structural areas. Additional field tests may also be performed in structural and non-structural areas at the discretion of the geotechnical consultant.

8.1.3 Import Soil

Import soil should consist of coarse-grained material (50 percent or more retained on the No. 200 sieve). Import soil should have a low solubility potential of 1.0 percent or less, as evaluated by SM2540C at an extraction ratio of 1:5 (soil to water) and corrected for dilution, a low sulfate content (less than 0.1 percent), and a very low to low expansion potential/plasticity index (EI less than 50, as evaluated by ASTM D4829; or Plasticity Index, PI, less than 15, as evaluated by ASTM D4318). Import soil should not contain organic matter, debris, other deleterious matter, or rocks or hard chunks larger than approximately 4 inches in nominal diameter. We further recommend that proposed import material be evaluated by the project's geotechnical consultant at the borrow source for its suitability prior to being

imported to the project site. Import soil should be moisture-conditioned, placed, and compacted in accordance with the recommendations set forth in the previous section.

8.1.4 Excavations and Dewatering

Groundwater was not encountered at the time of our subsurface exploration. Accordingly, dewatering measures are not anticipated. Groundwater levels will fluctuate due to seasonal variations from precipitation, irrigation, groundwater withdrawal or injection, and other factors.

8.1.5 Temporary Excavations and Shoring

Temporary slope configurations should be consistent with the requirements provided in the referenced Occupational Safety and Health Administration (OSHA) regulations (OSHA, 2023) document. Temporary slope surfaces should be kept moist to retard raveling and sloughing. Water should not be allowed to flow over the top of excavations in an uncontrolled manner. Stockpiled material and/or equipment should be kept back from the top of excavations a distance equivalent to the depth of the excavation or more. Workers should be protected from falling debris, sloughing, and raveling in accordance with OSHA regulations (OSHA, 2023). Temporary excavations should be observed by the project's geotechnical consultant so that appropriate additional recommendations may be provided based on the actual field conditions. Temporary excavations are time sensitive and failures are possible.

Shoring systems should be designed for the contractor by a professional engineer registered in the State of Utah. In addition to lateral earth pressures, shoring design should include surcharge loads exerted by adjacent existing roadways, structure foundations, construction equipment, construction traffic, material stockpiles, etc. located within a 1:1 (H:V) plane extending upward from the toe of the excavation. Shoring design should discuss the anticipated top deflection of the shoring components. Depending on the anticipated top deflection of the shoring components, settlement of buildings, buried utility lines, exterior flatwork, and other improvements located within close proximity (approximately 10 feet or more) of the temporary shoring should be considered.

8.2 Utility Installation

The contractor should take particular care to achieve and maintain adequate compaction of the backfill soils around manholes, valve risers, and other vertical pipeline elements where settlements are commonly observed. Use of controlled low strength material (CLSM) or a similar material should be considered in lieu of compacted soil backfill in areas with low tolerances for surface settlement. This may also reduce permeability of the utility trench backfill.

Pipe bedding materials, placement, and compaction should meet the specifications of the pipe manufacturer and applicable municipal standards. Materials proposed for use as pipe bedding should be tested for suitability prior to use.

Special care should be exercised to avoid damaging the pipe or other structures during the compaction of the backfill. In addition, the underside (or haunches) of the buried pipe should be supported on bedding material that is compacted as described above. This may need to be performed with placement by hand or small-scale compaction equipment.

Surface drainage should be designed to divert surface water away from utility trenches. Where topography, site constraints, or other factors limit or preclude adequate surface drainage, granular bedding materials should be surrounded by a non-woven geotextile fabric (e.g., TenCate Mirafi® 140N or equivalent) to reduce the migration of fines into bedding material, which can result in severe, isolated settlements.

8.3 Structure Foundations

Recommendations for conventional spread foundations and rammed aggregate piers are provided in the following sections.

8.3.1 Conventional Spread Footings

Conventional spread foundations may be utilized with an allowable bearing capacity of 1,900 pounds per square foot (psf). Spread footings should be founded on medium dense to very dense native granular soils, on stiff to hard native fine-grained soils, or on properly placed and compacted structural fill (reworked soils or import soils) extending to competent native soils as described above. The allowable bearing capacity may be increased by 200 psf for each additional 1 foot of width and 400 psf for each additional 1 foot of embedment up to 3,200 psf.

The allowable bearing capacity, which was developed considering a factor of safety of 2.5, may be increased by one-third for short-duration loads, such as wind or seismic. Additionally, shallow foundations should have an embedment depth of 30 inches or more below adjacent finished grade (for frost protection), and a width of 12 inches or more. Seismic parameters for design of structures at the site are provided in Table 2 in Section 5.3.

From a geotechnical standpoint, we recommend that footings be reinforced with four No. 4 or larger reinforcing bars, two placed near the top and two near the bottom of the footings.

Additional reinforcement may be recommended by the structural engineer. Lateral resistance for footings is presented in Section 8.5.

8.3.2 Rammed Aggregate Piers

As an alternate, in consideration of the moderate loads anticipated for the proposed structures, shallow foundations (spread and/or mat) bearing on an improved subgrade that has been remediated by the installation of a rammed aggregate pier (RAP) system may utilize higher bearing capacities. A RAP system will improve the density of the underlying soil and help reduce differential settlements.

RAP systems are typically designed for approximately 1 inch of settlement and typically result in design bearing capacities of roughly 4,000 to 6,000 psf. However, RAPs are proprietary design-build foundation systems that are typically designed and installed by a specialty subcontractor, such as Geopier Foundation Company or Keller. Although RAPs are proprietary systems, Ninyo & Moore requests the opportunity to review the design parameters, including the anticipated RAP embedment depths, once the specialty subcontractor is selected.

RAP systems can be designed to resist relatively light uplift loads, typical of low- to mid-rise structures. However, if the design results in significant tension loads, the use of uplift anchors, or a deep foundation system, such as ACIP piles, may be needed.

8.4 Settlement

Based on our evaluation of a uniform bearing pressure of 1.87 ksf across the footprint of the tank on soils not improved by a RAP system, settlement is anticipated on the order of approximately 2-1/2 inches. Due to the existing overburden associated with significant cuts on the uphill side of the proposed water tank, in contrast to the limited cut on the downhill side of the tank, we estimate static footing differential settlement will consist of the full potential settlement amount of approximately 2-1/2 inches. If the tank is not capable of sustaining this level of differential settlement, we recommend that the tank be supported on soils modified with a RAP system.

8.5 Lateral Earth Pressures

Lateral earth pressures may be estimated using the values provided below. These values are based on our observation of the on-site soils, considered no groundwater, and assume that the ground surface is horizontal for a distance of 10 feet, or three times the height generating the passive pressure, whichever is more. These values also assume that retaining walls will have a height of approximately 6 feet or less.

For passive resistance to lateral loads, we recommend a passive lateral earth pressure of 270 psf per foot of depth up to a value of 2,000 psf. We recommend that the upper 12 inches of soil not protected by pavement or a concrete slab be neglected when calculating passive resistance. The passive lateral earth pressure may be increased by one-third when considering loads of short duration such as wind or seismic forces. For active and at-rest lateral earth pressures, we recommend equivalent fluid pressures of 37 pcf and 54 pcf, respectively. In addition, for seismic active lateral earth pressures, an additional equivalent fluid pressure of 11 pcf should be added to the static active equivalent fluid pressure provided herein.

For frictional resistance to lateral loads, we recommend that a coefficient of friction of 0.51 be used between soil/soil contacts. A coefficient of friction of 0.33 may be used between soil and concrete contacts. Passive and frictional resistances may be used in combination, provided the passive resistance does not exceed one-half of the total allowable resistance.

Measures should be taken so that hydrostatic pressure does not build up behind retaining walls. Drainage measures should include free-draining granular backfill material and perforated drain pipes, or weep holes lined with polyvinyl chloride (PVC) pipe. Drain pipes should outlet away from structures and retaining walls should be waterproofed in accordance with the recommendations of a qualified civil engineer.

8.6 Concrete Slab-On-Grade Floors

Concrete slab-on-grade floors should be designed by the project's structural engineer based on anticipated loading conditions. Ninyo & Moore recommends that conventional concrete slab-on-grade floors for this project be founded on 6 inches of aggregate base overlying medium dense to very dense native granular soils, stiff to hard native fine-grained soils, or properly placed and compacted structural fill (reworked soils or import soils) extending to competent native soils as described above. Aggregate base underlying concrete slab-on-grade floors should be compacted to 95 percent or more of the laboratory maximum dry density (ASTM D1557).

Floor slabs should be 4 inches or more in thickness and reinforced with No. 3 steel reinforcing bars placed at 18 inches on-center both ways. Reinforcement of the slab should be placed at mid-height. We recommend that "chairs" be utilized to aid in the placement of the reinforcement. Increased slab thickness and reinforcement may be recommended by the structural engineer. As a means to reduce shrinkage cracks, we recommend that conventional slab-on-grade floors be provided with control joints in accordance with the recommendations of a qualified structural engineer. Recommendations regarding concrete utilized in construction of floor slabs are provided

in Section 8.11. As an alternative to slab reinforcement with steel reinforcing bars, post-tensioned slabs designed by a qualified structural engineer may be considered.

8.7 Exterior Concrete Flatwork

Ground-supported concrete flatwork may be subject to soil-related movements resulting from frost heave/settlement. Thus, where these types of elements abut rigid building foundations or isolated/suspended structures, differential movements should be anticipated. We recommend that flexible joints be provided in this situation to allow for differential movement.

Exterior concrete flatwork, such as walkways, should be founded on 6 inches of Untreated Base Course overlying medium dense to very dense native granular soils, stiff to hard native fine-grained soils, or properly placed and compacted structural fill (reworked soils or import soils) extending to competent native soils as described above. Aggregate base should be compacted to 95 percent or more relative compaction, as evaluated by ASTM D1557.

To reduce the potential for shrinkage cracks, the flatwork should be constructed with control joints spaced approximately 5 feet apart for walkways and approximately 10 feet on-center each way for larger slabs. Crack control joint spacing should be in accordance with recommendations of a qualified structural engineer. Reduced joint spacing may be recommended by the structural engineer.

Formation of shrinkage cracks in concrete slabs, and other cracks due to minor soil movement, may be further reduced by utilizing steel reinforcement, such as welded wire mesh. However, due to the inherent difficulty in positioning welded wire mesh in the middle of concrete flatwork, other crack control methods should be considered, such as placement in the concrete of No. 3 steel reinforcing bars at approximately 24 inches on-center each way. Reinforcement of the flatwork should be placed at approximately mid-height in the concrete utilizing “chairs.”

Exterior concrete flatwork, curbs, and gutters should be constructed in accordance with the recommendations of the project’s civil or structural engineer and governing agency requirements. Recommendations regarding concrete utilized in construction of proposed improvements are provided in Section 8.11.

8.8 Pavement Sections

The following sections provide pavement recommendations for on-site parking and access areas for the subject project.

8.8.1 Pavement Sections for Parking and Access Areas

To form a basis for design of flexible pavement for on-site paved parking and access areas, we have assumed the following:

- A design Equivalent Single Axial Load (ESAL) value of 3,000 for light-duty traffic areas; and an ESAL value of 16,000 for moderate-duty traffic areas.
- A design life of 20 years.
- A reliability of 90 percent.
- A standard deviation of 0.45.
- An initial serviceability index of 4.2.
- A terminal serviceability index of 2.5.
- A subgrade resilient modulus (MR) of 6,200 pounds per square inch (psi) based on the subgrade soils encountered and an estimated CBR value.

Using these values, structural numbers associated with the proposed parking and access areas were calculated using design procedures in accordance with the American Association of State Highway and Transportation Officials (AASHTO) method of designing flexible pavement (AASHTO, 1993) requirements. The following table presents recommended structural pavement sections placed over structural fill for on-site parking and access areas.

Traffic Type	Design ESAL	Pavement ($a_{\text{asphalt}} = 0.40$)	Base ($a_{\text{base}} = 0.10$)	Subgrade	Structural Number Provided	Structural Number Needed
		Asphalt Concrete Thickness (Inches)	Untreated Base Course Thickness (Inches)	Structural Fill Thickness (Inches)*		
Light-Duty	3,000	2.5	5.0	6.0	1.5	1.5
Moderate-Duty	16,000	3.0	7.0	6.0	1.9	1.9

Note: *Structural fill below pavement sections may include scarified and re-compacted native soil.

For any heavy truck traffic areas, we recommend a rigid pavement section consisting of 7 inches of Portland Cement Concrete over 6 inches or more of properly compacted granular Untreated Base Course. Untreated Base Course below rigid pavements should be underlain by medium dense to very dense native granular soils, stiff to hard native fine-grained soils, or properly placed and compacted structural fill (reworked soils or import soils) extending to competent native soils as described above. Concrete pavement should be designed in accordance with the American Concrete Institute (ACI) specifications*. The concrete should have a minimum 28-day unconfined compressive strength of 5,000 psi, a modulus of rupture of at least 600 psi, and contain 5.5 to 7.5 percent air-entrainment, as specified by ACI 318-

19 (ACI, 2019). We also recommend that a qualified structural engineer be consulted for appropriate reinforcement of concrete pavement.

8.8.2 Pavement Considerations

If the assumed traffic or design ESAL values are not considered appropriate, this office should be notified. In providing these recommendations for pavement sections, we have assumed that asphalt concrete will be mixed and placed in accordance with Section 02741 of the referenced Utah Department of Transportation (UDOT) 2024 Standard Specifications for Road and Bridge Construction (SSRBC). We have also assumed that the Untreated Base Course material will conform to Section 02721 of the referenced SSRBC (UDOT, 2023). Untreated Base Course material should be placed and compacted to 95 percent or more relative compaction, as evaluated by ASTM D1557, and in accordance with Section 02721 of the referenced UDOT SSRBC (UDOT, 2023).

We recommend that mix designs be made for the asphalt concrete and Portland cement concrete by an engineering company specializing in this type of work. In addition, paving operations should be observed and tested by a qualified testing laboratory.

Adequate surface drainage should be provided to reduce the potential for ponding and infiltration of water into the pavement and subgrade materials. We suggest that the paved areas have a surface gradient of 1 percent or more. In addition, surface runoff from surrounding areas should be intercepted, collected, and not permitted to flow onto the pavement or infiltrate the base and subgrade. We recommend that perimeter swales, edge drains, curbs and gutters, or combination of these drainage devices be constructed to reduce the adverse effects of surface water runoff.

8.9 Construction in Cold or Wet Weather

During construction, the site should be graded such that surface water can drain readily away from the structure and improvement areas. It is important to avoid ponding of water in or near excavations. Water that accumulates in excavations should be promptly pumped out or otherwise removed and these areas should be allowed to dry out before resuming construction. Berms, ditches, and similar means may be used to decrease stormwater entering the work area and to efficiently convey it to appropriate outlets off site.

Earthwork activities undertaken during the cold weather season may be difficult and should be done by an experienced contractor. Fill should not be placed on top of frozen soils. The frozen soils should be removed prior to placement of new engineered fill or other construction material.

Frozen soil should not be used as structural fill or backfill. The frozen soil may be reused (provided it meets the selection criteria) once it has thawed completely. In addition, compaction of the soils may be more difficult due to the viscosity change in water at lower temperatures.

If construction proceeds during cold weather, foundations, slabs, or other concrete elements should not be placed on frozen subgrade soil. Frozen soil should either be removed from beneath concrete elements, or thawed and re-compacted. To limit the potential for soil freezing, the time between excavation and construction should be minimized. Blankets, straw, soil cover, or heating may be used to decrease the potential of soil freezing.

8.10 Frost Heave

Site soils are susceptible to frost heave if allowed to become saturated and exposed to freezing temperatures and repeated freeze/thaw cycling. The formation of ice in the underlying soils can result in 2 or more inches of heave of pavements, flatwork, and other hardscaping in sustained cold weather. A portion of this movement may be recovered when the soils thaw, but due to loss of soil density, some degree of displacement will remain. Frost heave of hardscaping could also result in areas of fine-grained subgrade soils.

In areas where hardscape movements are a design concern (i.e. exterior flatwork located adjacent to the building within the doorway swing zone), replacement of the subgrade soils with 3 or more feet of clean, coarse sand or gravel, or supporting the element on foundations similar to the building, or spanning over a void should be considered. Detailed recommendations in this regard can be provided upon request.

8.11 Concrete and Corrosion Considerations

The corrosion potential of on-site soils to concrete and metal was evaluated in the laboratory using representative samples obtained from the exploratory borings. Results of these tests are presented in Appendix C. Recommendations regarding concrete to be utilized in construction of proposed improvements and for metal in contact with on-site soils are provided in the following sections.

8.11.1 Concrete

Chemical tests performed on selected samples of on-site soils indicated sulfate contents of less than 11 mg/kg (ppm). Based on review of the referenced International Building Code (ICC, 2018) and American Concrete Institute manual (ACI, 2019), the tested soils are considered to have a sulfate exposure class of S0. Additionally, concrete in contact with on-site soil is anticipated to have a freeze/thaw exposure class of F2. Accordingly, we

recommend that concrete in contact with on-site soils, along with subsurface walls up to 12 inches above finished grade have a design compressive strength of 4,500 psi or more, a water-cement ratio of 0.45 percent or less by weight, contain Type II cement, and contain 5.5 to 7.5 percent air-entrainment, as specified by ACI 318-19 (ACI, 2019). It is recommended that reinforcing bars in cast-against-grade concrete be covered by approximately 3 inches or more of concrete. Concrete should be placed with an approximate 4-inch slump and good densification procedures should be used during placement to reduce the potential for honeycombing. Concrete samples should be obtained, as indicated by ACI manual Section 318 (ACI, 2019), and the slump should be tested at the site by the project's geotechnical consultant. Structural concrete should be placed in accordance with American Concrete Institute (ACI, 2019) and project specifications.

8.11.2 Metal in Contact with On-Site Soils

Chemical tests performed on selected samples of on-site soils indicated severe corrosion potential to normal grade steel. Accordingly, Ninyo & Moore recommends that corrosion reduction methods be implemented for this project for metal in contact with soil. These corrosion reduction methods may include utilization of protective coatings, pipe sleeving, and/or appropriate cathodic protection as recommended by a qualified corrosion engineer. Where permitted by jurisdictional building codes, the use of plastic pipes for buried utilities should also be considered.

8.12 Moisture Infiltration Reduction and Surface Drainage

Infiltration of water into subsurface soils can lead to soil movement and associated distress, and chemically and physically related deterioration of concrete structures. To reduce the potential for infiltration of moisture into subsurface soils at the site, we recommend the following:

- Positive drainage should be established and maintained away from the proposed structure. Positive drainage may be established by providing a surface gradient for paved areas of 2 percent or more for a distance of 10 feet or more away from structure perimeters. For unpaved areas, positive drainage may be established by a slope of 5 percent or more for a distance of 10 feet or more away from structure perimeters, where possible.
- Adequate surface drainage should be provided to channel surface water away from on-site structures and to a suitable outlet such as a storm drain or the street. Adequate surface drainage may be enhanced by utilization of graded swales, area drains, and other drainage devices. Surface run-off should not be allowed to pond near structures.
- Building roof drains should have downspouts tightlined to an appropriate outlet, such as a storm drain or the street. If tightlining of the downspouts is not practicable, they should discharge 5 feet or more away from the building or onto paved areas that slopes away from the structure. Downspouts should not be allowed to discharge onto the ground surface adjacent to building foundations or concrete flatwork.

- Ninyo & Moore recommends that low-water use (drip irrigated) landscaping be utilized on site, particularly within 5 feet of the building and exterior site improvements, including areas of concrete flatwork and masonry block walls. Spray irrigation should not be used within 5 feet of the building. For drip irrigated foundation plating located within 5 feet of the building, we recommend incorporating a drainage system that drains the excess irrigation water away from this zone or soil moisture probes to prevent over watering.
- Irrigation heads should be oriented so that they spray away from building and block wall surfaces.
- Utility trenches should be backfilled with compacted, low permeability fill within 5 feet of the building. Planters, if any, should be maintained 10 feet or more from the building and constructed with closed bottoms or with drainage systems to drain excess irrigation away from the building.
- The facility owner should develop a program for the continued maintenance of the irrigation systems, which should be performed periodically, to prevent overwatering of landscaping within 5 to 10 feet of the building perimeter.

8.13 Observation and Testing

The geotechnical consultant should perform appropriate observation and testing services during fill placement, grading, and construction operations. These services should include observation of removal of soft, loose, undocumented fill, or otherwise unsuitable soils, evaluation of subgrade conditions where soil removals are performed, and performance of observation and testing services during placement and compaction of structural fill and backfill soils. The geotechnical consultant should also perform observation and testing services during placement of concrete, mortar, grout, asphalt concrete, and steel reinforcement.

The recommendations provided in this report are based on the assumption that Ninyo & Moore will provide geotechnical observation, testing, and inspection services during grading and construction. In the event that it is decided not to utilize the services of Ninyo & Moore during construction, we request that the selected consultant provide the client with a letter (with a copy sent to Ninyo & Moore) indicating that they fully understand Ninyo & Moore's recommendations, and that they are in full agreement with the design parameters and recommendations contained in this report.

8.14 Plan Review

The recommendations presented in this report are based on preliminary design information for the proposed project, as provided by Sunrise Engineering personnel, and on the findings of our geotechnical evaluation. When finished, project plans and specifications should be reviewed by the geotechnical consultant prior to submitting the plans and specifications for bid. Additional field exploration and laboratory testing may be needed upon review of the project design plans.

8.15 Pre-Construction Meeting

We recommend that a pre-construction meeting be held. The owner or the owner's representative, the architect, the civil engineer, the contractor, and the geotechnical consultant should be in attendance to discuss the plans and the project.

9 LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. The conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. Changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the

broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

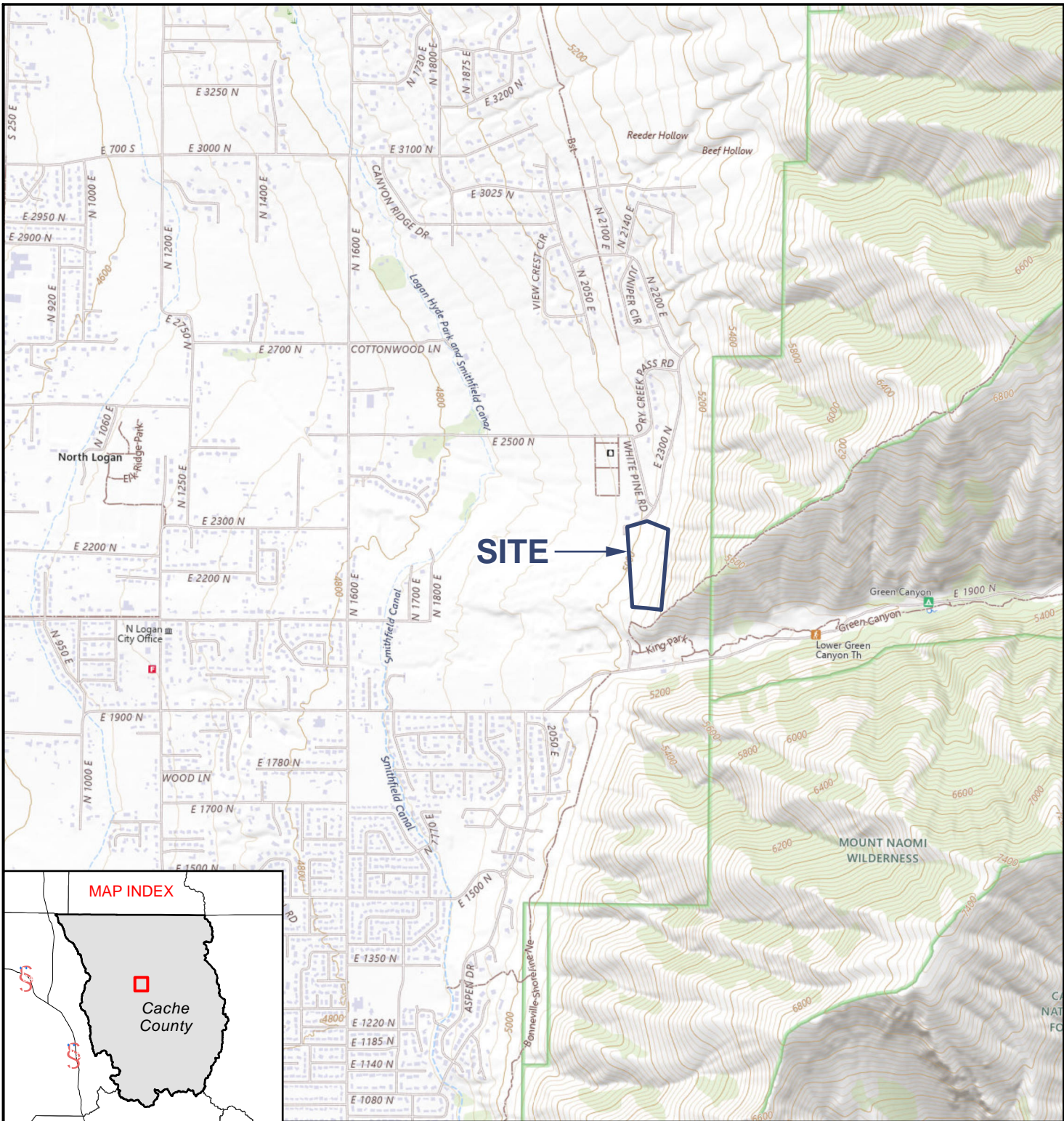
This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

10 REFERENCES

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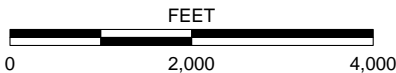
FIGURES



SITE

MAP INDEX

Cache County

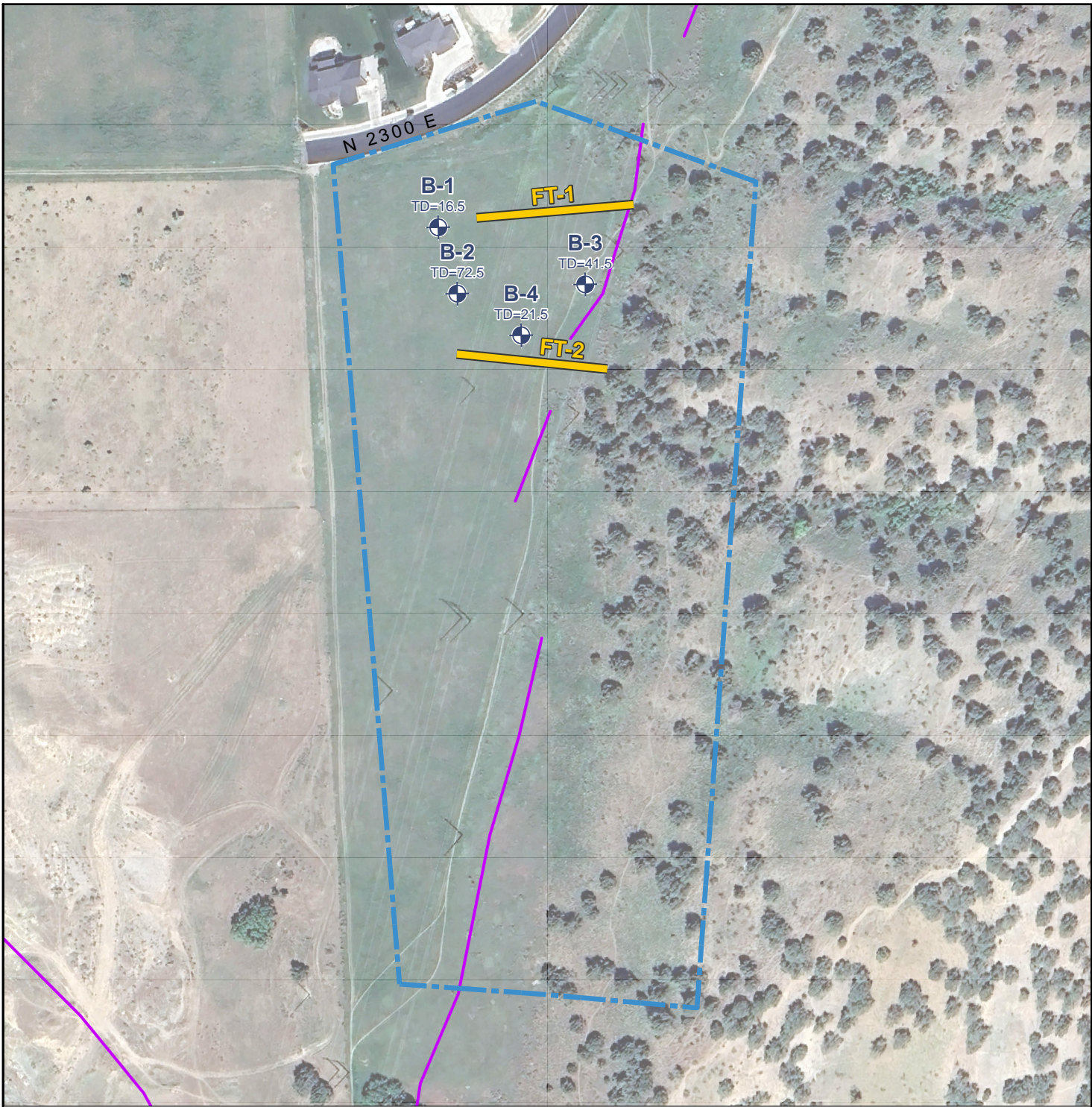


NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE. | SOURCE: USGS, 2024

FIGURE 1

SITE LOCATION

NORTH LOGAN WATER TANK
SOUTH OF NORTH 2300 EAST, NORTH LOGAN, UTAH



LEGEND

- 
B-4 BORING
 TD=21.5 TD=TOTAL DEPTH IN FEET
- 
FT-2 FAULT TRENCH
- 
 SITE BOUNDARY
- 
 EAST CACHE FAULT ZONE (USGS, 2024)

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE. | SOURCE: GOOGLE, 2025

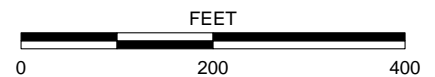
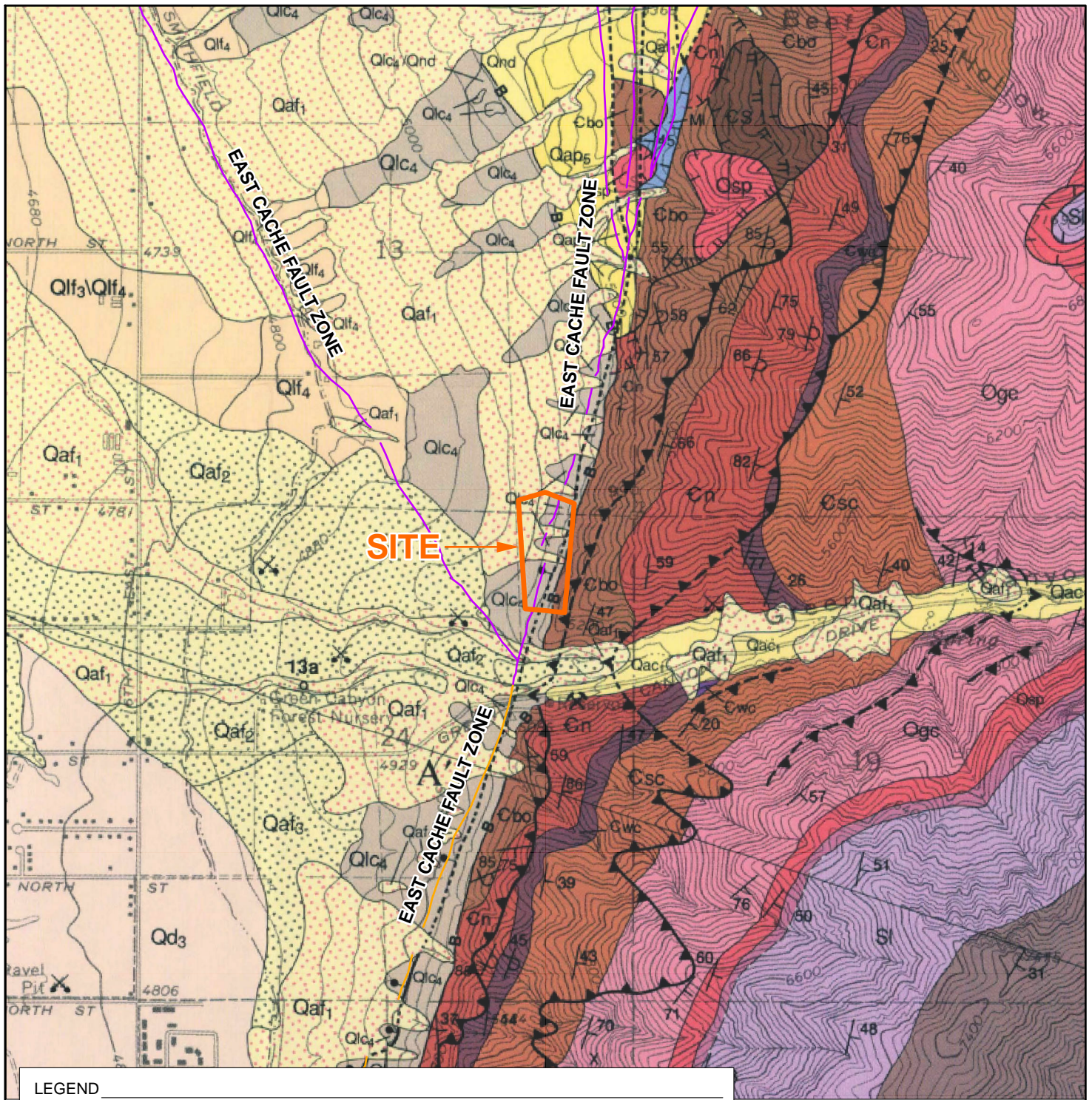


FIGURE 2

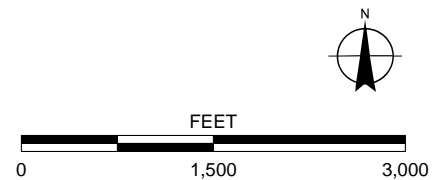
EXPLORATION LOCATIONS

NORTH LOGAN WATER TANK
 SOUTH OF NORTH 2300 EAST, NORTH LOGAN, UTAH



LEGEND

	YOUNGER POST-LAKE BONNEVILLE ALLUVIAL-FAN DEPOSITS		BLOOMINGTON FORMATION
	LACUSTRINE NEARSHORE DEPOSITS (COBBLES TO FINE SAND)	USGS FAULTS	
	LACUSTRINE NEARSHORE DEPOSITS (COBBLES TO SAND)		QUATERNARY (POTENTIALLY ACTIVE)
			HOLOCENE ACTIVE



NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE. | SOURCES: FAULTS - UNITED STATES GEOLOGICAL SURVEY (USGS), 2024, QUATERNARY FAULTS AND FOLD DATABASE OF THE UNITED STATES: [HTTP://EARTHQUAKES.USGS.GOV/QFAULTS/](http://earthquakes.usgs.gov/qfaults/); GEOLOGY - LOWE, M., 1993, PROVISIONAL GEOLOGIC MAP OF THE SMITHFIELD QUADRANGLE, CACHE COUNTY, UTAH. M-143. UGS. 1:24,000 SCALE

FIGURE 3

GEOLOGY

NORTH LOGAN WATER TANK
SOUTH OF NORTH 2300 EAST, NORTH LOGAN, UTAH



APPENDIX A

Boring and Trench Logs

APPENDIX A

BORING AND TRENCH LOGS

Field Procedure for the Collection of Disturbed Soil Samples

Disturbed soil samples were obtained in the field using the following methods.

Bulk Soil Samples

Bulk samples of representative earth materials were obtained from the exploratory borings. The samples were bagged and transported to the laboratory for testing.

The Standard Penetration Test (SPT) Sampler

Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-3/8 inches. In general accordance with ASTM D1586, the sampler was driven into the ground with a 140-pound hammer free-falling from a height of 30 inches and the number of blows recorded on the boring logs as an index to the relative resistance of the materials sampled. Soil samples were observed and removed from the sampler, bagged, sealed, and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples

Relatively undisturbed soil samples were obtained in the field using a modified split barrel drive sampler. The sampler, with an external diameter of 3.0 inches, was lined with 1-inch-long, thin, brass rings with inside diameters of 2.4 inches. In general accordance with ASTM D3550, the sampler was driven into the ground with a 140-pound hammer free-falling from a height of 30 inches and the number of blows recorded on the boring logs as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

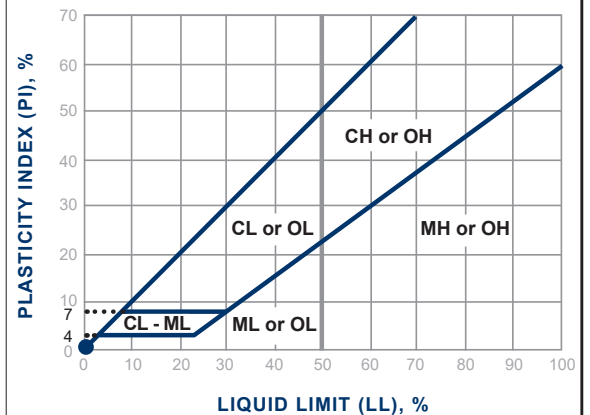
Soil Classification Chart Per ASTM D 2488

Primary Divisions		Secondary Divisions				
		Group Symbol	Group Name			
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	GRAVEL more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL		
			GP	poorly graded GRAVEL		
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt		
			GP-GM	poorly graded GRAVEL with silt		
			GW-GC	well-graded GRAVEL with clay		
			GP-GC	poorly graded GRAVEL with clay		
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL		
			GC	clayey GRAVEL		
		SAND 50% or more of coarse fraction passes No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND	
				SP	poorly graded SAND	
	SAND with DUAL CLASSIFICATIONS 5% to 12% fines		SW-SM	well-graded SAND with silt		
			SP-SM	poorly graded SAND with silt		
			SW-SC	well-graded SAND with clay		
			SP-SC	poorly graded SAND with clay		
	SAND with FINES more than 12% fines		SM	silty SAND		
			SC	clayey SAND		
	FINE-GRAINED SOILS 50% or more passes No. 200 sieve		SILT and CLAY liquid limit less than 50%	INORGANIC	CL	lean CLAY
					ML	SILT
		CL-ML			silty CLAY	
		ORGANIC		OL (PI > 4)	organic CLAY	
OL (PI < 4)				organic SILT		
CH				fat CLAY		
SILT and CLAY liquid limit 50% or more		INORGANIC	MH	elastic SILT		
			OH (plots on or above "A"-line)	organic CLAY		
		ORGANIC	OH (plots below "A"-line)	organic SILT		
			PT	Peat		
Highly Organic Soils						

Grain Size

Description	Sieve Size	Grain Size	Approximate Size
Boulders	> 12"	> 12"	Larger than basketball-sized
Cobbles	3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	Rock-salt-sized to pea-sized
	Medium	#40 - #10	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	Flour-sized to sugar-sized
Fines	Passing #200	< 0.0029"	Flour-sized and smaller

Plasticity Chart



Apparent Density - Coarse-Grained Soil

Apparent Density	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

Consistency - Fine-Grained Soil

Consistency	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

BORING LOG EXPLANATION SHEET

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	
	Bulk	Driven						
0	■							Bulk sample. Modified split-barrel drive sampler. No recovery with modified split-barrel drive sampler. Sample retained by others. Standard Penetration Test (SPT). No recovery with a SPT. Shelby tube sample. Distance pushed in inches/length of sample recovered in inches. No recovery with Shelby tube sampler. Continuous Push Sample. Seepage. Groundwater encountered during drilling. Groundwater measured after drilling.
5	X		XX/XX					
10	○			○				
15						■	SM	MAJOR MATERIAL TYPE (SOIL): Solid line denotes unit change.
15						- - -	CL	Dashed line denotes material change. Attitudes: Strike/Dip b: Bedding c: Contact j: Joint f: Fracture F: Fault cs: Clay Seam s: Shear bss: Basal Slide Surface sf: Shear Fracture sz: Shear Zone sbs: Shear Bedding Surface
20								The total depth line is a solid line that is drawn at the bottom of the boring.

DEPTH (feet)	SAMPLES Bulk Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED <u>9/27/24</u> BORING NO. <u>B-1</u>
							GROUND ELEVATION <u>4,997' ± (MSL)</u> SHEET <u>1</u> OF <u>1</u>
							METHOD OF DRILLING <u>Diedrich D-50 Hollow Stem Auger Drilling Rig</u>
							DRIVE WEIGHT <u>140 lbs. (Auto. Trip)</u> DROP <u>30"</u>
							SAMPLED BY <u>EAS</u> LOGGED BY <u>EAS</u> REVIEWED BY <u>REG/EDE</u>
							DESCRIPTION/INTERPRETATION
0						SC	NATIVE SOIL: Light brown, moist, medium dense, clayey SAND with gravel.
		4/6" 7/6" 10/6"					
		14/6" 16/6" 13/6"	6.8	94.8			
5						CL	Light brown, moist, very stiff, lean CLAY; few to little sand; trace gravel.
		4/6" 5/6" 6/6"					
		4/6" 9/6" 16/6"	15.6	88.4			
10						ML	Yellowish light brown, moist, medium dense, sandy SILT.
		4/6" 5/6" 7/6"					
15							Total Depth = 16.5 feet. Groundwater not encountered during drilling. Backfilled on 9/30/24.
20							Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

FIGURE A- 1

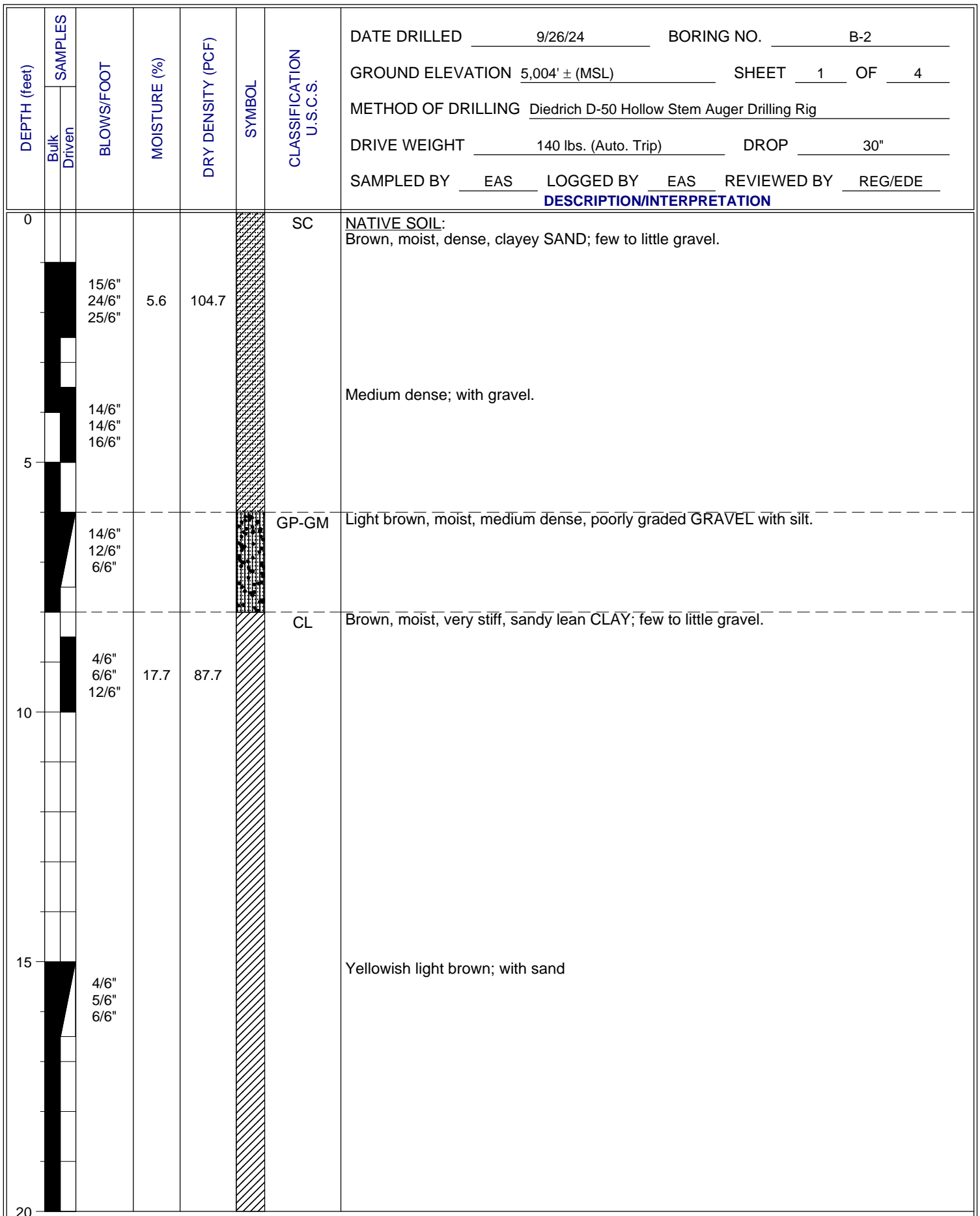


FIGURE A-2


DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED <u>9/26/24</u> BORING NO. <u>B-2</u>		
	Bulk	Driven						GROUND ELEVATION <u>5,004' ± (MSL)</u>	SHEET <u>2</u> OF <u>4</u>	
								METHOD OF DRILLING <u>Diedrich D-50 Hollow Stem Auger Drilling Rig</u>		
								DRIVE WEIGHT <u>140 lbs. (Auto. Trip)</u> DROP <u>30"</u>		
								SAMPLED BY <u>EAS</u> LOGGED BY <u>EAS</u> REVIEWED BY <u>REG/EDE</u>		
								DESCRIPTION/INTERPRETATION		
20			2/6" 5/6" 9/6"	18.1	99.0		CL	NATIVE SOIL: (Continued) Grayish brown, moist, very stiff, lean CLAY with sand.		
25		2/6" 3/6" 4/6"							Stiff; sandy.	
30		1/6" 3/6" 5/6"	17.0	85.9					Brown.	
35		5/6" 8/6" 8/6"							Very stiff; few gravel.	
40										

FIGURE A-3

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED <u>9/26/24</u> BORING NO. <u>B-2</u>	
	Bulk	Driven						GROUND ELEVATION <u>5,004' ± (MSL)</u>	SHEET <u>3</u> OF <u>4</u>
								METHOD OF DRILLING <u>Diedrich D-50 Hollow Stem Auger Drilling Rig</u>	
								DRIVE WEIGHT <u>140 lbs. (Auto. Trip)</u> DROP <u>30"</u>	
								SAMPLED BY <u>EAS</u> LOGGED BY <u>EAS</u> REVIEWED BY <u>REG/EDE</u>	
								DESCRIPTION/INTERPRETATION	
40			5/6" 29/6" 30/6"	9.6	112.0		GC	NATIVE SOIL: (Continued) Light brown, moist, dense, clayey GRAVEL.	
45			5/6" 9/6" 10/6"				CL	Brown, moist, very stiff, lean CLAY with gravel.	
50			22/6" 26/6" 28/6"	8.4	117.5		GC	Brown, moist, dense, clayey GRAVEL.	
55			5/6" 23/6" 20/6"				GP-GM	Light brown, moist, very dense, poorly graded GRAVEL with silt,	
60									

FIGURE A-4

DEPTH (feet)	SAMPLES	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED <u>9/26/24</u> BORING NO. <u>B-2</u>
							GROUND ELEVATION <u>5,004' ± (MSL)</u> SHEET <u>4</u> OF <u>4</u>
							METHOD OF DRILLING <u>Diedrich D-50 Hollow Stem Auger Drilling Rig</u>
							DRIVE WEIGHT <u>140 lbs. (Auto. Trip)</u> DROP <u>30"</u>
							SAMPLED BY <u>EAS</u> LOGGED BY <u>EAS</u> REVIEWED BY <u>REG/EDE</u>
							DESCRIPTION/INTERPRETATION
60		5/6" 18/6" 29/6"	20.2	101.0		CL	NATIVE SOIL: (Continued) Brown, moist, hard, lean CLAY.
65		5/6" 8/6" 11/6"					Very stiff.
70		25/6" 50/5"	13.1				Hard; trace gravel. Wet.
							Auger refusal on flowing sands. Total Depth = 72.5 feet. Groundwater was encountered at a depth of approximately 71.0 feet during drilling. Backfilled on 9/26/24.
75							Notes: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report.
							The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
80							

FIGURE A- 5

DEPTH (feet)	BULK SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED	BORING NO.	
							10/1/24	B-3	
							GROUND ELEVATION	SHEET	OF
							5,036' ± (MSL)	1	3
							METHOD OF DRILLING		
							Diedrich D-50 Hollow Stem Auger Drill Rig		
							DRIVE WEIGHT	DROP	
							140 lbs. (Auto. Trip)	30"	
							SAMPLED BY	LOGGED BY	REVIEWED BY
							JCH	JCH	REG/EDE
							DESCRIPTION/INTERPRETATION		
0						SM	<p>TOPSOIL: Unit is approximately 4 inches thick.</p> <p>NATIVE SOIL: Brown, dry, very dense, silty SAND; trace gravel and roots.</p> <p>Roots grade out.</p> <p>Dense.</p>		
	14/6" 19/6" 22/6"		2.7	112.2					
	20/6" 23/6" 21/6"								
5						GC	Brown, dry, medium dense, clayey GRAVEL with sand.		
	5/6" 7/6" 7/6"								
10			8.8	104.4		CL	Brown, moist, stiff, lean CLAY; trace gravel.		
	6/6" 6/6" 6/6"								
15						SM	Brown, moist, medium dense, silty SAND; trace gravel.		
	3/6" 4/6" 7/6"								
20									

FIGURE A- 6

DEPTH (feet)	BULK SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED	BORING NO.	
							10/1/24	B-3	
							GROUND ELEVATION	SHEET	OF
							5,036' ± (MSL)	2	3
							METHOD OF DRILLING		
							Diedrich D-50 Hollow Stem Auger Drill Rig		
							DRIVE WEIGHT	DROP	
							140 lbs. (Auto. Trip)	30"	
							SAMPLED BY	LOGGED BY	REVIEWED BY
							JCH	JCH	REG/EDE
							DESCRIPTION/INTERPRETATION		
20	13/6" 23/6" 44/6"		2.4	124.2		SM	NATIVE SOIL: (Continued) Brown, moist, dense, silty SAND; trace gravel.		
25	10/6" 20/6" 23/6"						Very dense.		
30	14/6" 23/6" 30/6"		4.8	118.1			Dense.		
35	6/6" 9/6" 11/6"						Medium dense.		
40									

FIGURE A-7

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED <u>10/1/24</u> BORING NO. <u>B-3</u>	
	Bulk	Driven						GROUND ELEVATION <u>5,036' ± (MSL)</u>	SHEET <u>3</u> OF <u>3</u>
								METHOD OF DRILLING <u>Diedrich D-50 Hollow Stem Auger Drill Rig</u>	
								DRIVE WEIGHT <u>140 lbs. (Auto. Trip)</u> DROP <u>30"</u>	
								SAMPLED BY <u>JCH</u> LOGGED BY <u>JCH</u> REVIEWED BY <u>REG/EDE</u>	
								DESCRIPTION/INTERPRETATION	
40			20/6" 12/6" 12/6"				SM	<p><u>NATIVE SOIL:</u> (Continued) Brown, moist, dense, silty SAND; trace gravel.</p>	
								<p>Total Depth = 41.5 feet. Groundwater not encountered during drilling. Backfilled on 10/1/24.</p> <p><u>Notes:</u> Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.</p> <p>The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.</p>	
45									
50									
55									
60									

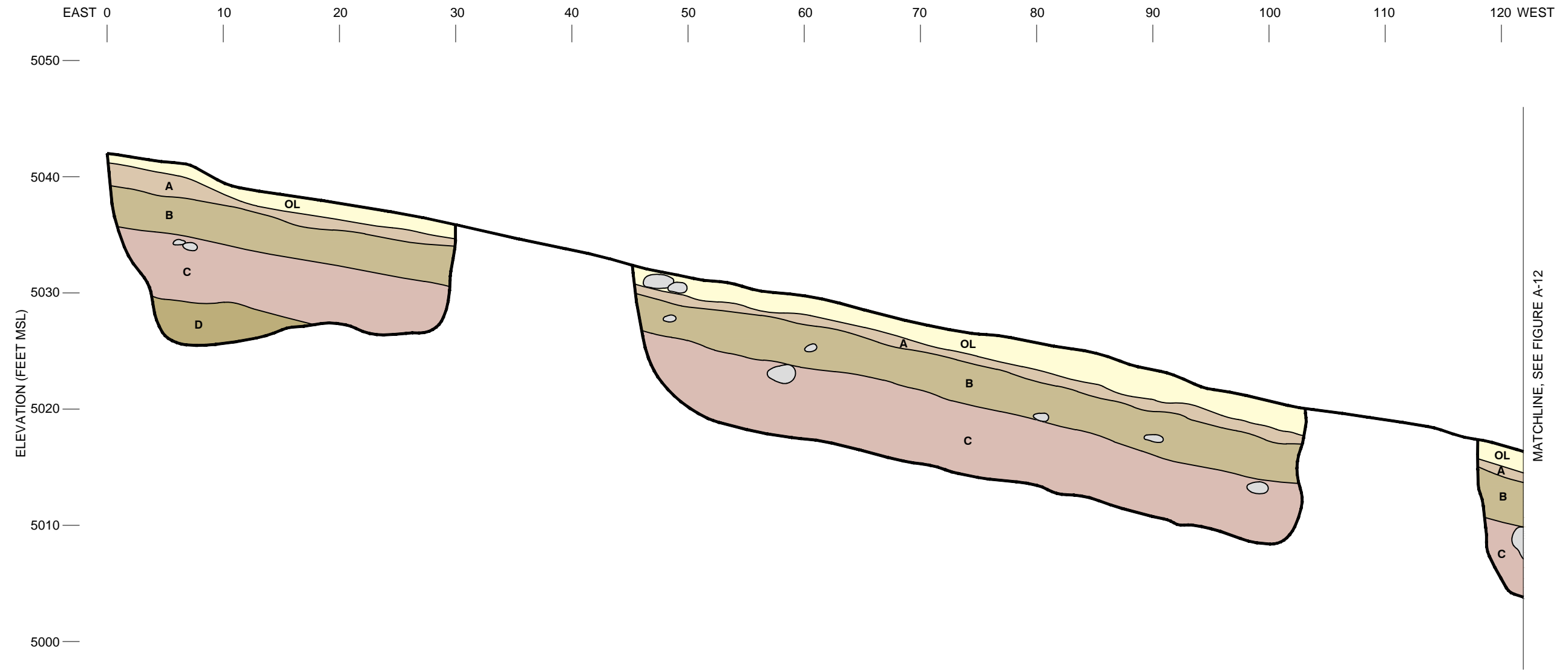
FIGURE A- 8

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED <u>10/1/24</u> BORING NO. <u>B-4</u>	
	Bulk	Driven						GROUND ELEVATION <u>5,021' ± (MSL)</u>	SHEET <u>1</u> OF <u>2</u>
								METHOD OF DRILLING <u>Diedrich D-50 Hollow Stem Auger Drill Rig</u>	
								DRIVE WEIGHT <u>140 lbs. (Auto. Trip)</u> DROP <u>30"</u>	
								SAMPLED BY <u>JCH</u> LOGGED BY <u>JCH</u> REVIEWED BY <u>REG/EDE</u>	
								DESCRIPTION/INTERPRETATION	
0							GW	<p>TOPSOIL: Unit is approximately 4 inches thick.</p> <p>NATIVE SOIL: Brown, moist, medium dense, well-graded GRAVEL with sand.</p>	
9/6"									
15/6"									
26/6"									
							SM	Brown, dry, dense, silty SAND; trace gravel.	
13/6"									
11/6"									
14/6"									
5				5.5	108.6			Medium dense.	
11/6"									
12/6"									
14/6"									
10									
4/6"									
3/6"									
6/6"									
15								Moist; dense.	
16/6"									
19/6"									
24/6"									
20									

FIGURE A-9

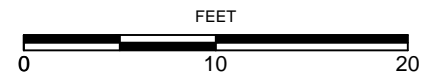
DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED <u>10/1/24</u> BORING NO. <u>B-4</u>	
	Bulk	Driven						GROUND ELEVATION <u>5,021' ± (MSL)</u>	SHEET <u>2</u> OF <u>2</u>
								METHOD OF DRILLING <u>Diedrich D-50 Hollow Stem Auger Drill Rig</u>	
								DRIVE WEIGHT <u>140 lbs. (Auto. Trip)</u> DROP <u>30"</u>	
								SAMPLED BY <u>JCH</u> LOGGED BY <u>JCH</u> REVIEWED BY <u>REG/EDE</u>	
								DESCRIPTION/INTERPRETATION	
20			6/6" 6/6" 7/6"				SM	<p><u>NATIVE SOIL:</u> (Continued) Brown, moist, medium dense, silty SAND.</p>	
								<p>Total Depth = 21.5 feet. Groundwater not encountered during drilling. Backfilled on 10/1/24.</p> <p><u>Notes:</u> Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.</p> <p>The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.</p>	
25									
30									
35									
40									

FIGURE A- 10

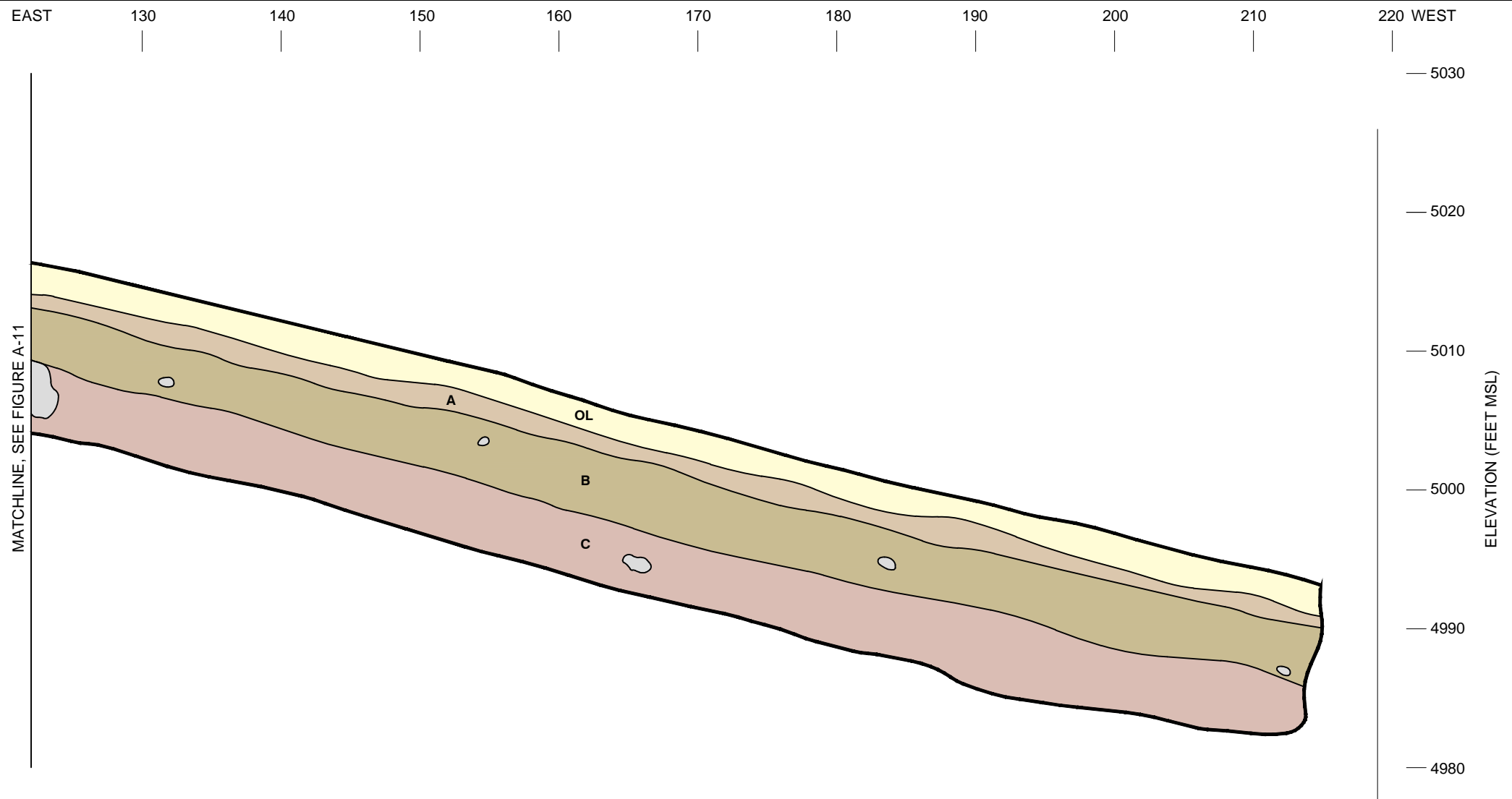


LEGEND	
OL	Dark brown, moist, very stiff, sandy lean CLAY with gravel; with organics
A	Brown, moist, medium dense, clayey SAND with gravel; trace organics
B	Whitish light brown, moist, medium dense, clayey SAND with gravel; trace organics
C	Brown, moist, medium dense, clayey GRAVEL with sand; occasional cobbles and boulders
D	Brown, moist, very stiff, sand CLAY; occasional cobbles and boulders
	Boulder

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

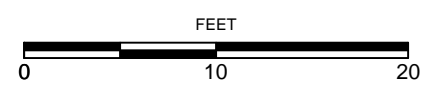


A11 800408001 TRENCH LOG FT-1A.DWG AOB



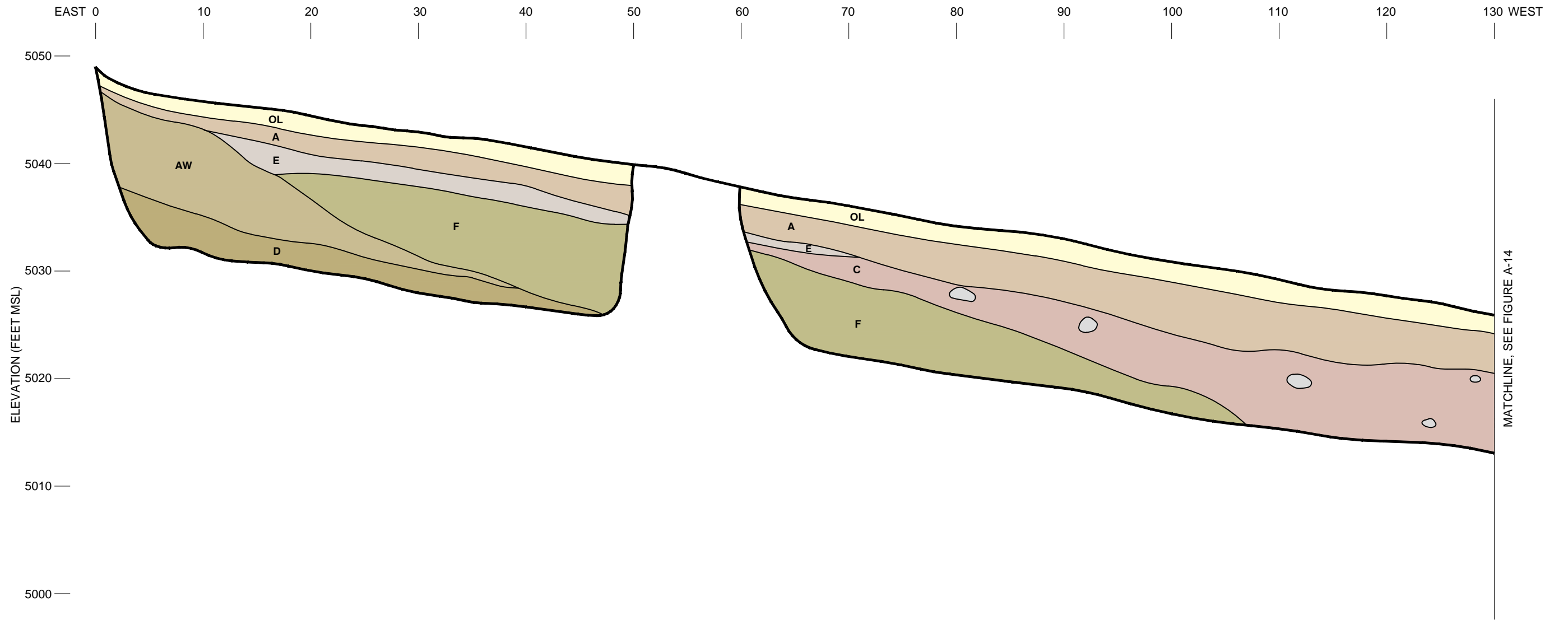
LEGEND	
OL	Dark brown, moist, very stiff, sandy lean CLAY with gravel; with organics
A	Brown, moist, medium dense, clayey SAND with gravel; trace organics
B	Whitish light brown, moist, medium dense, clayey SAND with gravel; trace organics
C	Brown, moist, medium dense, clayey GRAVEL with sand; occasional cobbles and boulders
D	Brown, moist, very stiff, sand CLAY; occasional cobbles and boulders
	Boulder

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.



A12 800408001 TRENCH LOG FT-1B.DWG AOB



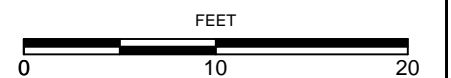


MATCHLINE, SEE FIGURE A-14

LEGEND

- OL** Dark brown, moist, very stiff, sandy lean CLAY with gravel
- A** Brown, moist, medium dense, silty GRAVEL with sand; trace organics
- AW** Alluvial wedge with interbedded layers. Layers range from approximately 1 to 4 inches thick. Layers consisted of poorly graded sand with silt and gravel, silty sand, and sandy lean clay.
- C** Brown, moist, medium dense, clayey GRAVEL with sand; occasional cobbles and boulders
- D** Brown, moist, very stiff, sand CLAY; occasional cobbles and boulders
- E** Gray, moist, medium dense, poorly graded GRAVEL with silt and sand
- F** Brown, moist, medium dense, clayey lean SAND; trace gravel
- Boulder

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.



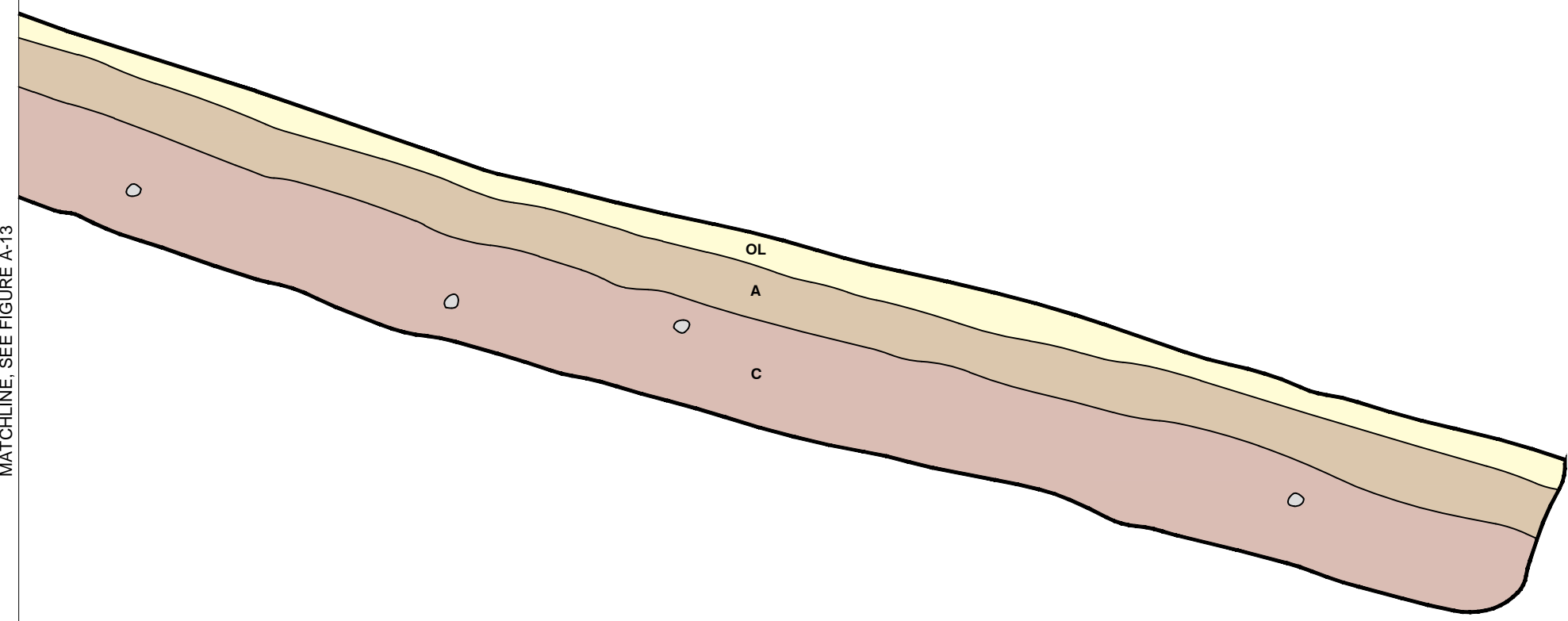
A13 800408001 TRENCH LOG FT-2A.DWG AOB

FIGURE A-13

EAST 130 140 150 160 170 180 190 200 210 220 230 240 WEST

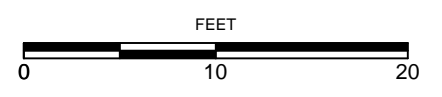
MATCHLINE, SEE FIGURE A-13

— 5030
 — 5020
 — 5010
 — 5000
 — 4990
 — 4980
 ELEVATION (FEET MSL)



LEGEND	
OL	Dark brown, moist, very stiff, sandy lean CLAY with gravel
A	Brown, moist, medium dense, silty GRAVEL with sand; trace organics
AW	Alluvial wedge with interbedded layers. Layers range from approximately 1 to 4 inches thick. Layers consisted of poorly graded sand with silt and gravel, silty sand, and sandy lean clay.
C	Brown, moist, medium dense, clayey GRAVEL with sand; occasional cobbles and boulders
D	Brown, moist, very stiff, sand CLAY; occasional cobbles and boulders
E	Gray, moist, medium dense, poorly graded GRAVEL with silt and sand
F	Brown, moist, medium dense, clayey lean SAND; trace gravel
	Boulder

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.



A14-800408001 TRENCH LOG FT-2B.DWG AOB

FIGURE A-14



APPENDIX B

Laboratory Test Results

APPENDIX B

LABORATORY TEST RESULTS

Classification

Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D2488. Soil classifications are indicated on the logs of the exploratory borings in Appendix A.

In-Place Moisture and Density

The moisture content and dry density of relatively undisturbed samples obtained from the exploratory excavations were evaluated in general accordance with ASTM D2937. The test results are presented on the logs of the exploratory excavations in Appendix A.

Gradation Analysis

Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D7928, C117, and C136. These test results were utilized in evaluating the soil classifications in accordance with the USCS. The grain-size distribution curves are shown on Figure B-1 through Figure B-4.

Atterberg Limits

Tests were performed on selected representative soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D4318. These test results were utilized to evaluate soil classification in accordance with the USCS. The test results and classifications are shown on Figure B-5.

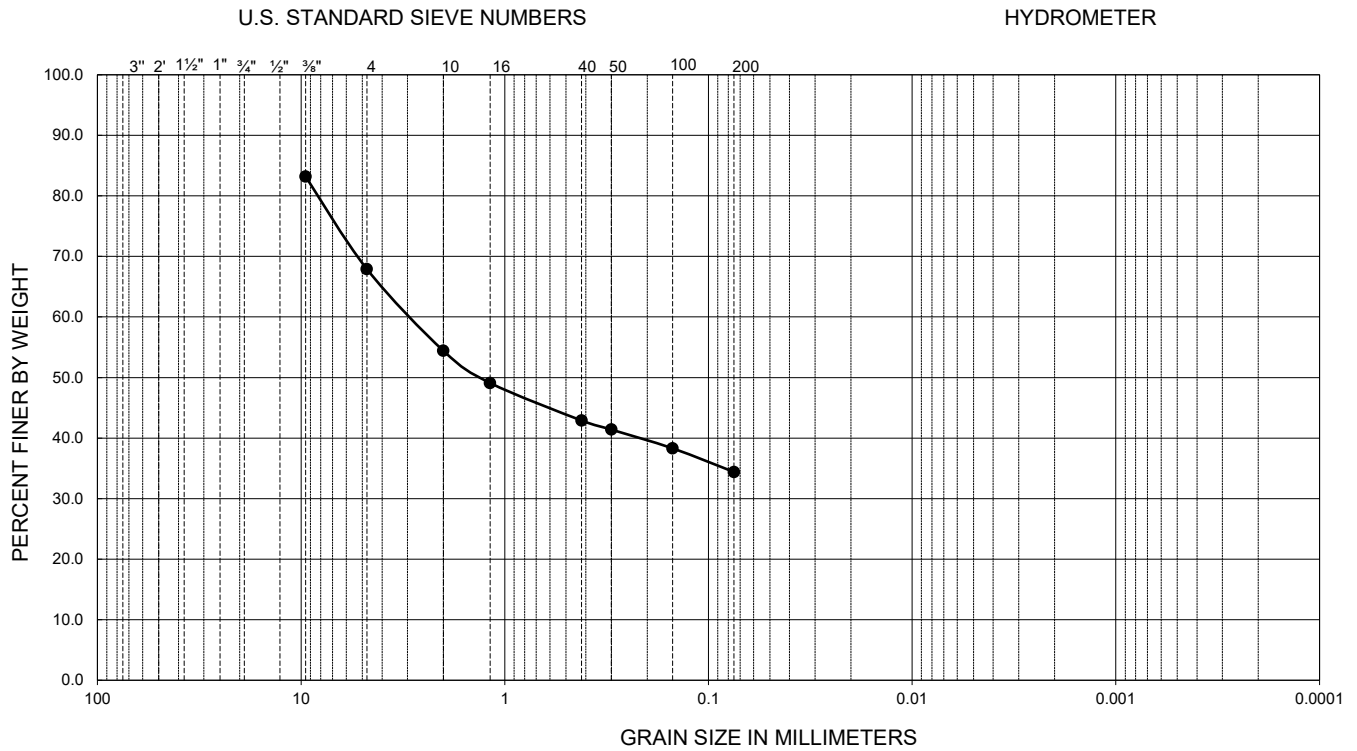
Consolidation

Consolidation tests were performed on selected relatively undisturbed soil samples in general accordance with ASTM D2435. The samples were inundated during testing to represent adverse field conditions. The percent of consolidation for each load cycle was recorded as a ratio of the amount of vertical compression to the original height of the sample. The consolidation test results are summarized graphically on Figure B-6 and Figure B-7.

Direct Shear

Direct shear testing was performed on an undisturbed sample in general accordance with ASTM D3080 to evaluate the shear strength characteristics of selected materials. The sample was inundated during shearing to represent adverse field conditions. The results are shown on Figure B-8.

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



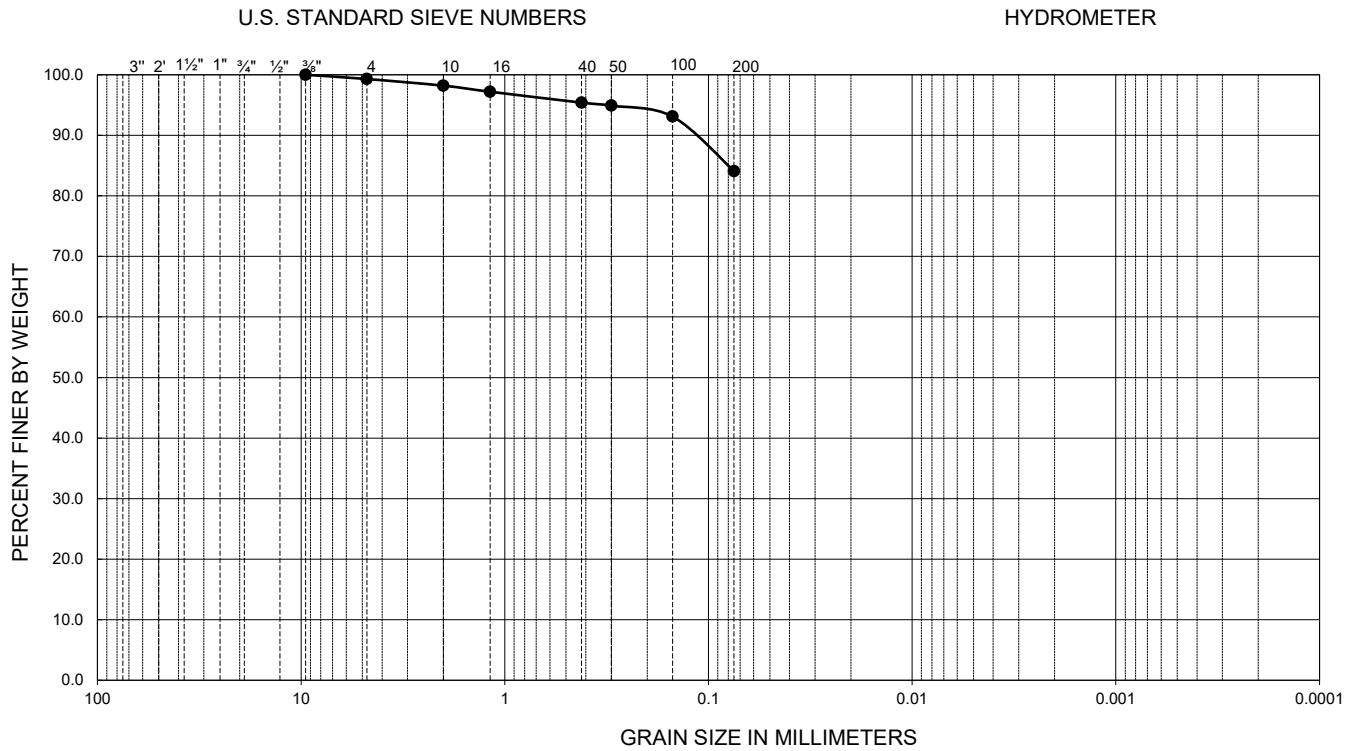
Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (%)	USCS
●	B-1	0.0-3.0	31	19	12	--	--	2.86	--	--	34.4	SC

Material Percent by Weight			Soil Type	
Gravel	Sand	Fines	Clayey SAND with gravel	
32.1	33.5	34.4		
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D7928, C136, and C117			Moisture Content	
			3.6%	

FIGURE B-1

GRADATION TEST RESULTS

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



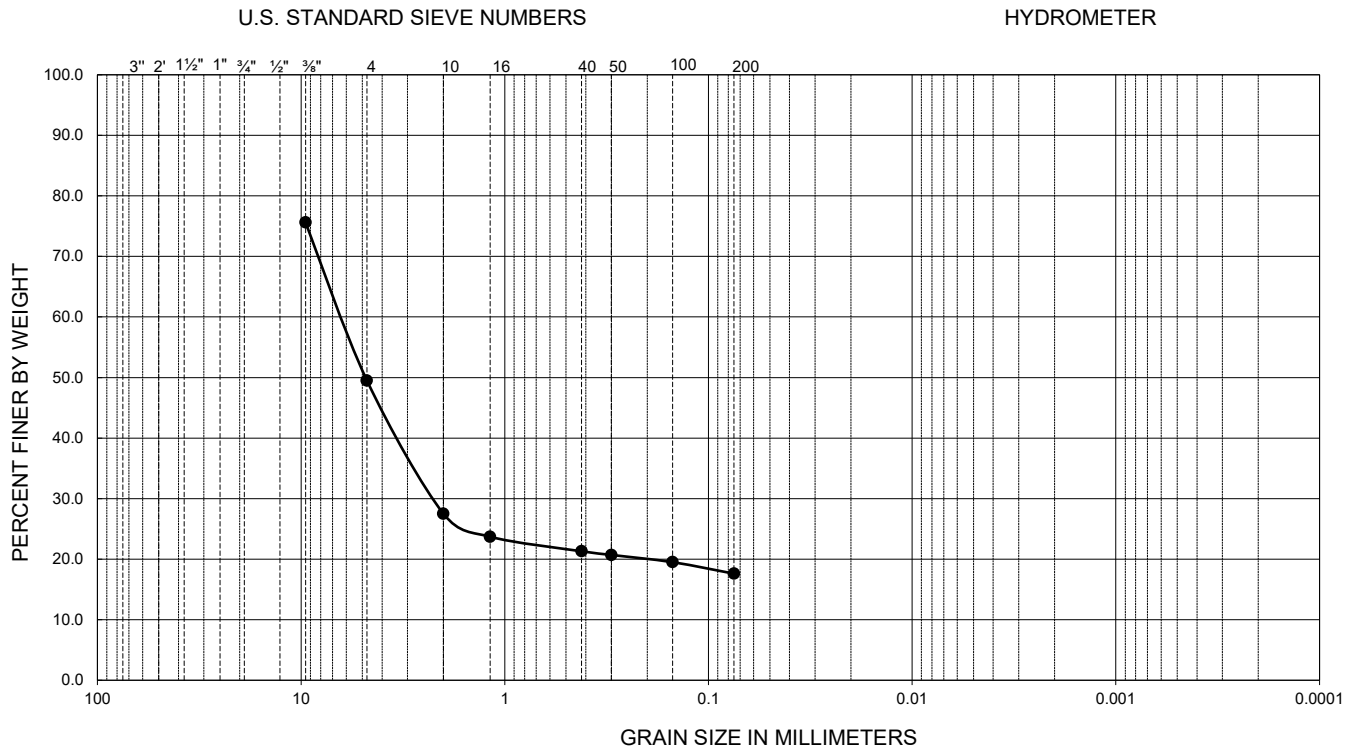
Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (%)	USCS
●	B-2	15.0-20.0	25	16	9	--	--	--	--	--	84.1	CL

Material Percent by Weight			Soil Type	
Gravel	Sand	Fines	Lean CLAY with sand	
0.7	15.2	84.1	Moisture Content	
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D7928, C136, and C117			14.2%	

FIGURE B-2

GRADATION TEST RESULTS

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



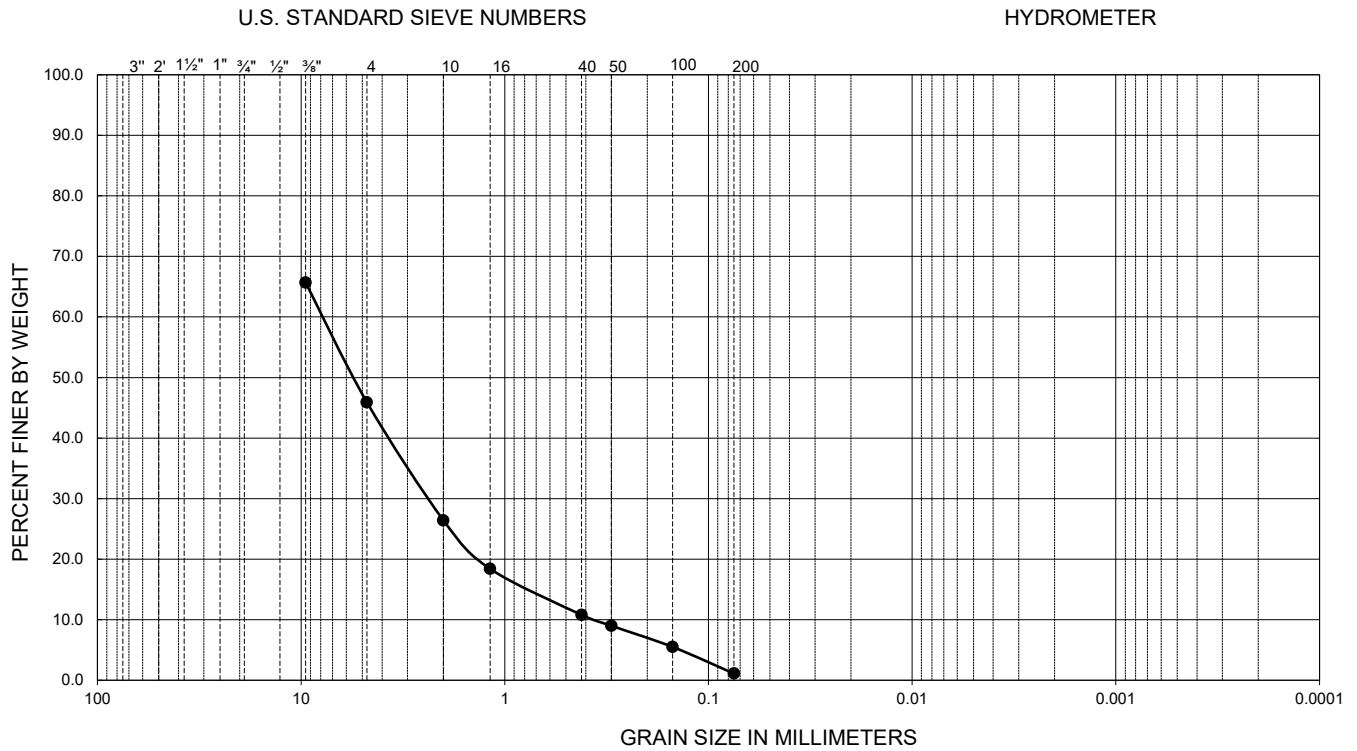
Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (%)	USCS
●	B-3	7.0-10.0	26	16	10	--	2.21	6.28	--	--	17.6	GC

Material Percent by Weight			Soil Type	
Gravel	Sand	Fines	Clayey GRAVEL with sand	
50.5	31.9	17.6		
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D7928, C136, and C117			Moisture Content	
			1.5%	

FIGURE B-3

GRADATION TEST RESULTS

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



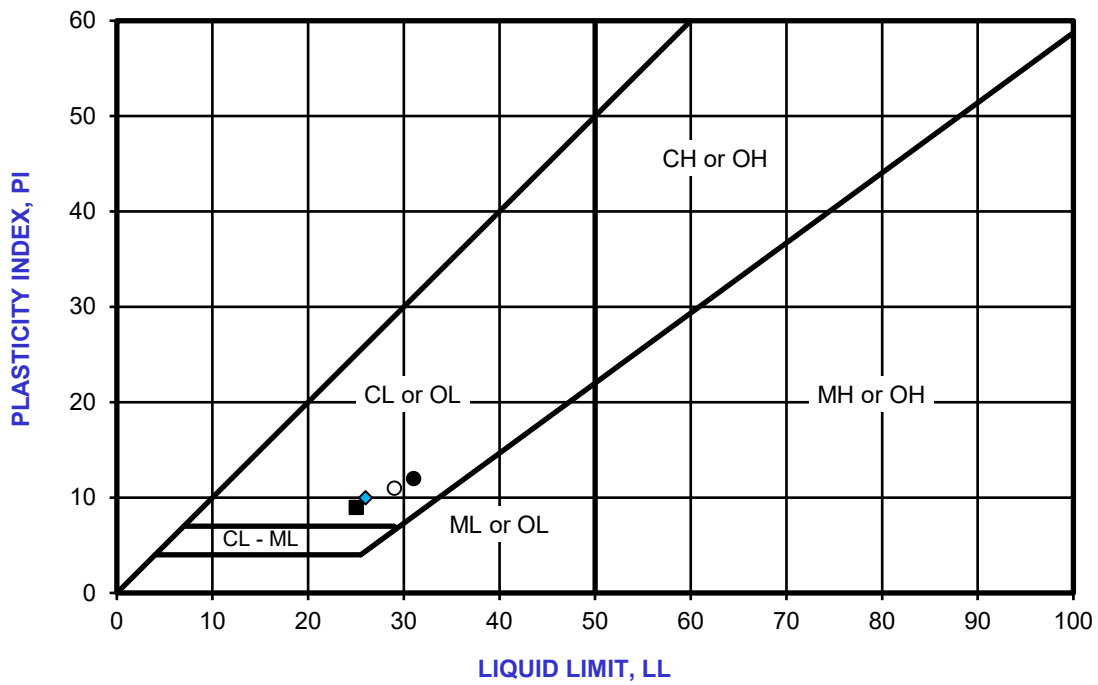
Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (%)	USCS
●	B-4	1.0-2.5	29	11	18	0.36	2.35	7.78	21.5	2.0	1.1	GW

Material Percent by Weight			Soil Type	
Gravel	Sand	Fines	Well-graded GRAVEL with sand	
54.1	44.8	1.1		
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D7928, C136, and C117			Moisture Content	
			3.1%	

FIGURE B-4

GRADATION TEST RESULTS

SYMBOL	LOCATION	DEPTH (ft)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS
●	B-1	0.0 - 3.0	31	19	12	CL	SC
■	B-2	15.0-20.0	25	16	9	CL	CL
◆	B-3	7.0-10.0	26	16	10	CL	GC
○	B-4	1.0-5.0	29	18	11	CL	GW



PERFORMED IN GENERAL ACCORDANCE WITH D4318

FIGURE B-5



APPENDIX C

Chemical Test Results

APPENDIX C

CHEMICAL TEST RESULTS

The results of the chemical tests are provided in this appendix.



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Certificate of Analysis

Ninyo and Moore
Edgar Salinas
871 Robinson Drive
North Salt Lake, UT 84054

PO#:
Receipt: **10/10/24 17:01 @ 24.9 °C**
Date Reported: 10/23/2024
Project Name: **800408001 North Logan Water Tank**

Sample ID: **B-3, 1.0'-2.5'**

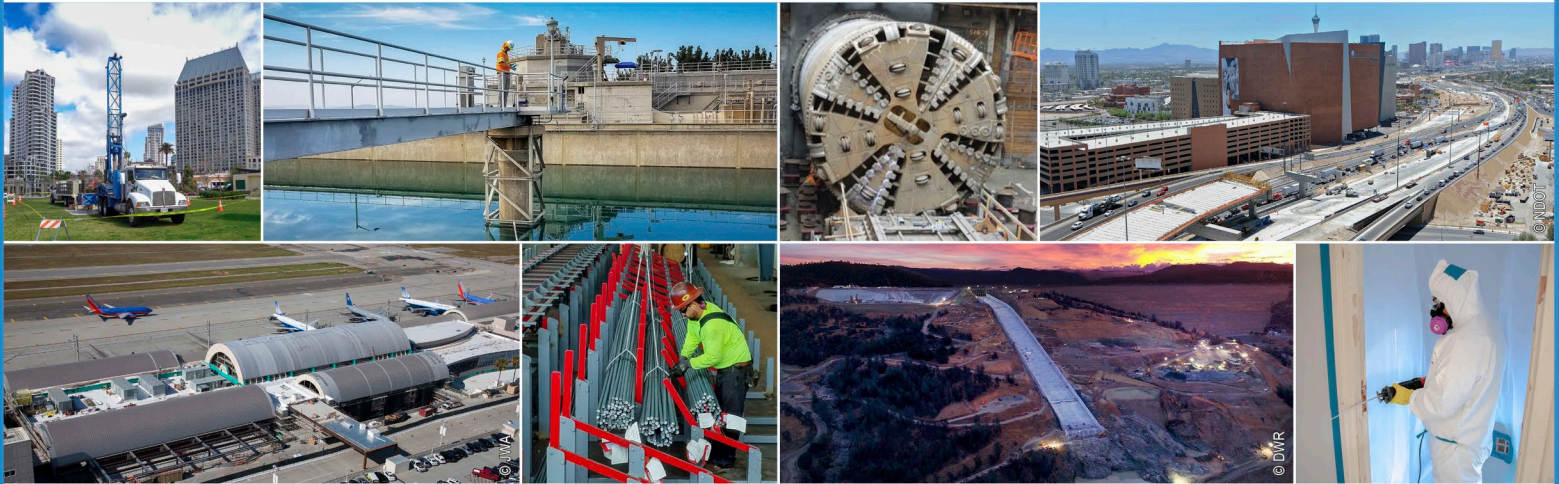
Matrix: **Solid**

Lab ID: **24J1060-01**

Date Sampled: **10/1/24 8:30**

Sampled By: **John Harris**

	<u>Result</u>	<u>Units</u>	<u>Minimum Reporting Limit</u>	<u>Method</u>	<u>Preparation Date/Time</u>	<u>Analysis Date/Time</u>	<u>Flag(s)</u>
Inorganic							
Chloride, Soluble (IC)	30	mg/kg dry	11	EPA 300.0	10/14/24	10/15/24	
pH	8.4	pH Units	0.1	EPA 9045D	10/11/24 11:51	10/11/24 12:11	SPH
Resistivity	18.2	ohm m	1.0	SSSA 10-3.3	10/15/24	10/15/24	
Sulfate, Soluble (IC)	ND	mg/kg dry	11	EPA 300.0	10/14/24	10/15/24	
Total Dissolved Solids, Soluble	2420	mg/kg dry	527	SM 2540 C	10/17/24	10/17/24	
Total Solids	94.9	%	0.1	CTF8000	10/14/24	10/14/24	



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