



Trout Unlimited Paris Creek Irrigation Diversion Project



Technical Specifications Issued For Construction

Prepared For: Trout Unlimited

Prepared By: QRS Consulting



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SECTION 01 11 00 - SUMMARY OF WORK

PART 1 -- GENERAL

1.1 SUMMARY

- A. The WORK to be performed under this Contract shall consist of furnishing tools, equipment, materials, supplies, and manufactured articles, and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all work or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The WORK shall be complete, and all work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete and proper construction of the WORK in good faith shall be provided by the CONTRACTOR as though originally so indicated, at no increase in cost to the OWNER.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

- A. The WORK of this Contract comprises the construction of a new irrigation diversion and intake structure for Paris Relief Ditch (Paris Relief) and Upper Southfield Ditch (Southfield). The major elements of the WORK are as follows:

1. **Phase I:**

- a. Installation of ~2,000 feet of let down cattle fencing with gates
- b. Three in-stream rock vane diversion structures in Paris Creek
- c. A dual bay concrete intake structure with trash racks and sluice gates
- d. A 90-foot-long by ~14-foot-wide riprap and cobble lined intake channel with ecoblock retaining walls.
- e. A concrete drop inlet structure with stoplogs and grating
- f. Installation of a 758-foot-long C900 pipeline including 700 feet of 30-inch-diameter pipe and 58 feet of 48-inch-diameter pipe. The pipeline WORK includes installation of all fittings and appurtenances required including, but not limited to, air vents, reducers, elbows, pipe bedding, and flanged connections.
- g. Installation of approximately 215 feet of ¾" minus crushed aggregate access road adjacent to the intake structure.

2. **Phase II:**

- a. Demolition of the existing Paris Hydro Facility tailrace structure
- b. Installation of a concrete flow splitter box with stoplogs, grating, sluice gates, and jersey barriers.

- c. Installation of 30-inch diameter and 16-inch diameter steel pipe to connect the flow splitter box to the existing Paris Relief and Southfield Ditch pipelines. Piping shall include IDWR flow meters and a precast concrete meter box.
 - d. Installation of a 26-foot-long by 10-foot-wide riprap lined overflow channel.
 - e. Installation of jersey barriers
- B. The WORK is located on private property adjacent to Paris Canyon Road, approximately 2.3-miles west of the intersection of Paris Canyon Road and South Main St. (Hwy 89), Paris, Idaho.

1.3 CONTRACT METHOD

- A. The WORK hereunder will be constructed under a single lump sum contract with the following exceptions:
- 1. Construction of Phase II WORK elements under this Contract is dependent on receiving formal approval from the Federal Energy Regulatory Commission (FERC) for the decommissioning of PacifiCorp's Paris Hydroelectric Facility (Facility).
 - 2. In the event that FERC approval for decommissioning of the Facility is delayed (preventing construction of Phase II WORK prior to start of the 2025 irrigation season) or denied, the OWNER retains the right to eliminate Phase II work elements from the scope of work and all associated Phase II costs from the CONTRACTORs bid proposal.
 - 3. In the event that FERC approval for decommissioning of the Facility is delayed (preventing construction of Phase II WORK in 2024), the OWNER and CONTRACTOR may extend the CONTRACT and renegotiate CONTRACTOR fees resulting from the delay in work. (i.e. remobilization and changes to material costs).
 - 4. Paris Relief Canal Company intends to replace the existing 30" diameter steel pipeline across Paris Creek with a 36" diameter pipe. The ENGINEER will provide the CONTRACTOR revised design documents for Phase II WORK to accommodate the change in the Paris Relief pipe size. The CONTRACTOR and OWNER will negotiate a change order for the design revisions to the Phase II WORK.
- B. Contract funding requires that the WORK meet Build America Buy America Act (2021) requirements. To receive payment, the CONTRACTOR shall provide the OWNER with documentation showing that all manufactured materials installed meet the Build America Buy America Act.

1.4 WORK BY OTHERS

- A. Where 2 or more contracts are being performed at one time on the same Site or adjacent land in such manner that work under one contract may interfere with work under another, the OWNER will determine the sequence and order of the Work in either or both contracts. When the Site of one contract is the necessary or convenient means of access for performance of work under another, the OWNER may grant privilege of access or other reasonable privilege to the contractor so desiring, to the extent, amount,

and in manner and at time that the OWNER may determine. No OWNER determination of method or time or sequence or order of the work or access privilege shall be the basis for a claim for delay or damage except under provisions of the General Conditions for temporary suspensions of the work. The CONTRACTOR shall conduct its operations so as to cause a minimum of interference with the work of such other contractors, and shall cooperate fully with such contractors to allow continued safe access to their respective portions of the Site, as required to perform work under their respective contracts.

- B. **Interference With Work On Utilities:** The CONTRACTOR shall cooperate fully with all utility forces of the OWNER or forces of other public or private agencies engaged in the relocation, altering, or otherwise rearranging of any facilities which interfere with the progress of the WORK, and shall schedule the WORK so as to minimize interference with said relocation, altering, or other rearranging of facilities.

1.5 WORK SEQUENCE

- A. The CONTRACTOR's attention is directed to the fact that during the irrigation period of May through September, no interruption in the flow to Paris Relief or Southfield ditches can be accommodated, and the CONTRACTOR shall so schedule its construction operations that no interference with the operation of the system will occur during this critical period.

1.6 CONTRACTOR USE OF SITE

- A. The CONTRACTOR's use of the Site shall be limited to its construction operations, including on-Site storage of materials, on-Site fabrication facilities, and field offices.

1.7 OUTAGE PLAN AND REQUESTS

- A. Unless the Contract Documents indicate otherwise, the CONTRACTOR shall not interrupt service to the City of Paris's (City) water supply system or Paris Relief irrigation operations, or any other facility without permission from the ENGINEER or owners of the respective facility.
 - 1. Outages and service connections shall be performed post irrigation season, unless specifically allowed by the ENGINEER or facility owners.
 - 2. The maximum duration of any outage to the City water supply system shall be specified by Paris Mayor Brad Wilkes.
- B. Where the WORK requires modifications to existing facilities or construction of new facilities and connection of new facilities to existing facilities, the CONTRACTOR shall submit a detailed outage plan and schedule for the ENGINEER'S approval a minimum of two (2) weeks in advance of the time that such outage is planned.
- C. A completed System Outage Request form (blank furnished by the ENGINEER) shall accompany each outage plan. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of the Contract Documents. The outage plan shall describe the CONTRACTOR's method for completing the WORK within the required outage time frame. All costs for preparing and implementing the outage plans shall be at no increase in cost to the OWNER.

- D. The ENGINEER shall be notified in writing at least one week in advance of the required outage if the schedule for performing the work has changed or if revisions to the outage plan are required.
- E. The CONTRACTOR shall provide written confirmation of the shutdown date and time two (2) working days prior to the actual shutdown.

1.8 OWNER USE OF THE SITE

- A. The OWNER may utilize all or part of the existing Site during the entire period of construction for the conduct of the OWNER's normal operations. The CONTRACTOR shall cooperate and coordinate with the OWNER to facilitate the OWNER's operations and to minimize interference with the CONTRACTOR's operations at the same time. In any event, the OWNER shall be allowed access to the Site during the period of construction.

1.9 PROJECT MEETINGS

A. **Preconstruction Conference**

1. Prior to the commencement of WORK at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by the CONTRACTOR'S Project Manager, its superintendent, and its subcontractors as the CONTRACTOR deems appropriate. Other attendees will be:
 - a. ENGINEER and the Resident Project Representative.
 - b. Representatives of OWNER.
 - c. Representatives of Paris Relief Canal Company and Southfield Ditch Company.
 - d. PacifiCorp representatives.
 - e. Others as requested by CONTRACTOR, OWNER, or ENGINEER.
2. The CONTRACTOR shall bring the preconstruction conference submittals in accordance with Section 01 33 00 - Contractor Submittals.
3. 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 complete agenda will be furnished to the CONTRACTOR prior to the meeting date. However, the CONTRACTOR should be prepared to discuss all of the items listed below.
 - a. Status of CONTRACTOR's insurance and bonds.
 - b. CONTRACTOR's tentative schedules.
 - c. Transmittal, review, and distribution of CONTRACTOR's submittals.
 - d. Processing applications for payment.

- e. Maintaining record documents.
 - f. Critical work sequencing.
 - g. Field decisions and Change Orders.
 - h. Use of Site, office and storage areas, security, housekeeping, and OWNER's needs.
 - i. Major equipment deliveries and priorities.
 - j. CONTRACTOR's assignments for safety and first aid.
 - k. Daily Report Form which the ENGINEER will furnish.
 - l. Submittal Transmittal Form which the ENGINEER will furnish.
4. The OWNER and ENGINEER will preside at the preconstruction conference and will arrange for keeping and distributing the minutes to all persons in attendance.

B. Progress Meetings

1. The ENGINEER will schedule and hold regular on-Site progress meetings at least monthly and at other times as requested by CONTRACTOR or as required by progress of the WORK. The CONTRACTOR, ENGINEER, and all subcontractors active on the Site shall attend each meeting. CONTRACTOR may at its discretion request attendance by representatives of its suppliers, manufacturers, and other subcontractors.
2. The ENGINEER will preside at the progress meetings and will arrange for keeping and distributing the minutes. The purpose of the meetings is to review the progress of the WORK, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop. During each meeting, the CONTRACTOR shall present any issues that may impact its progress with a view to resolve these issues expeditiously.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

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SECTION 01 14 00 - CONSTRUCTION AND SCHEDULE CONSTRAINTS

PART 1 -- GENERAL

1.1 SUMMARY

- A. WORK shall be scheduled, sequenced, and performed in coordination with the decommissioning of PacifiCorp's Paris Hydroelectric Facility, Paris Relief irrigation operations, and the on-going operation of City's potable water supply system.
- B. The CONTRACTOR shall incorporate the construction and schedule constraints of this Section in preparing the construction schedules.

1.2 PROJECT SCHEDULE

- A. Project schedule shall be coordinated with the OWNER. Construction of the Work shall begin in 2024. Construction sequencing and schedule shall consider the following constraints:
 - 1. Construction shall commence summer of 2024 with approval from the OWNER and land-owners.
 - 2. In-water WORK shall be completed within the in-water work window for Paris Creek.
 - 3. Phase 1 work shall be completed by December 31st, 2024.
 - 4. Demolition and Construction of Phase II WORK elements (tailrace demolition and flow splitter box construction) shall be scheduled upon receipt of approval by PacifiCorp representative. Phase II WORK may be postponed until 2025 or removed from the scope of work if approval for decommissioning of PacifiCorp's Paris Hydroelectric Project is not received in 2024.
 - 5. If Phase II WORK is approved to proceed under the current contract, construction of Phase II WORK items shall not interrupt water supply service to Paris Relief or Southfield irrigation diversions (typically operated May – September). All work must be complete prior to the beginning of the 2025 irrigation season.

1.3 OUTAGE REQUESTS

- A. Installation of the irrigation pipeline may require temporary outage of the City's potable water supply system and rerouting of existing supply lines between the water main and chlorination building. In such cases, the CONTRACTOR shall coordinate WORK with the ENGINEER and City representatives as described below. The CONTRACTOR shall submit a detailed outage plan and time schedule for construction activities.
- B. The outage plans shall be submitted to the OWNER and ENGINEER for acceptance a minimum of 2 weeks in advance of the time that such outages are required. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of this Section. The outage plan shall describe the CONTRACTOR's method for completing the Work within the defined outage period. Costs for preparing and implementing the outage plans shall be the responsibility of the CONTRACTOR as part of the WORK.

- C. The CONTRACTOR shall not begin an alteration affecting existing facilities until specific written approval has been granted by the ENGINEER in each case.
- D. The ENGINEER will coordinate the CONTRACTOR's planned procedure with the treatment facility personnel. The ENGINEER has the authority to modify any proposed shutdown procedures if such procedures would adversely impact the plant operations.
- E. The ENGINEER shall be notified in writing at least one week in advance of the required outage if the schedule for performing the WORK has changed or if revisions to the outage plan are required. The CONTRACTOR shall provide written confirmation of the shutdown date and time two (2) Days prior to the actual shutdown.

1.4 SCHEDULE CONSTRAINTS

- A. **General:** It is the CONTRACTOR's responsibility to coordinate and plan the construction activities to integrate each schedule constraint into performance of the overall WORK.
- B. The listing of schedule constraints below does not mean that every constraint or special condition has been identified. The list does not substitute for the CONTRACTOR's coordination and planning for completion of the WORK within the Contract Times.
- C. The following constraints affect the construction schedule.
 - 1. End of irrigation season, typically end of September. Date to be coordinated with Paris Relief representative.
 - 2. PacifiCorp's decommissioning of the hydroelectric facility. Date to be coordinated with PacifiCorp representatives.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION

SECTION 01 33 00 - CONTRACTOR SUBMITTALS

PART 1 -- GENERAL

1.1 SUMMARY

- A. Wherever submittals are required in the Contract Documents, submit them to the OWNER or OWNER's Resident Representative as directed.
- B. Within seven (7) Days after the date of commencement as stated in the Notice to Proceed, the CONTRACTOR shall submit the following items for review:
 - 1. A preliminary schedule of Shop Drawings, Samples, and proposed Substitutes ("Or-Equal") submittals listed in the Bid. The schedule of submittals shall be based on CONTRACTOR's priority, planned construction sequence and schedule, long lead items, and size of submittal package. Allow time for resubmittals.
 - 2. A list of permits and licenses the CONTRACTOR shall obtain, indicating the agency required to grant the permit and the expected date of submittal for the permit and required date for receipt of the permit.

1.2 PRECONSTRUCTION CONFERENCE SUBMITTALS

- A. At the preconstruction conference of Section 01 11 00 - Summary of Work, the submit the following items to the OWNER for review:
 - 1. A revised schedule of Shop Drawings, Samples, and proposed Substitute ("Or-Equal") submittals listed in the Bid.
 - 2. A list of permits and licenses the CONTRACTOR shall obtain, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.

1.3 SHOP DRAWINGS

- A. All shop drawing submittals along with the shop drawing transmittal form, shall be made electronically in ".pdf" format and distributed by email from the CONTRACTOR to the OWNER's Resident Project Representative (RPR). The OWNER'S RPR shall be responsible to distribute each shop drawing to all reviewers and to receive and compile all review comments generated.
- B. Wherever called for in the Contract Documents or where required by the ENGINEER, the CONTRACTOR shall furnish a clear (non-scanned) electronic version, of each Shop Drawing submittal. Shop Drawings may include detail design calculations, shop-prepared drawings, fabrication and installation drawings, erection drawings, lists, graphs, catalog sheets, data sheets, and similar items. Whenever the CONTRACTOR is required to submit design calculations as part of a submittal, such calculations shall bear

the signature and seal of an engineer registered in the appropriate branch and in the state wherein the project is located, unless otherwise indicated.

C. Shop Drawing submittals shall be accompanied by the OWNER's standard submittal transmittal form, an electronic copy of which is available from the OWNER. A submittal without the form or where applicable items on the form are not completed will be returned for resubmittal.

D. Organization

1. A single submittal transmittal form shall be used for each technical specification section or item or class of material or equipment for which a submittal is required. A single submittal covering multiple sections will not be acceptable, unless the primary specification references other sections for components.
2. On the transmittal form, index the components of the submittal and insert tabs in the submittal to match the components. Relate the submittal components to specification paragraph and subparagraph, Drawing number, detail number, schedule title, room number, or building name, as applicable.
3. Unless indicated otherwise, terminology and equipment names and numbers used in submittals shall match those used in the Contract Documents.

E. Format

1. Minimum sheet size shall be 8-1/2 inches by 11-inches. Maximum sheet size shall be 11-inches by 17-inches. Every page in a submittal shall be numbered in sequence. All sheets shall be submitted on one (1) pdf file and arranged.
2. Where product data from a manufacturer is submitted, clearly mark which model is proposed, with complete pertinent data capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports. Sufficient level of detail shall be presented for assessment of compliance with the Contract Documents.
3. Each submittal shall be assigned a unique number. Submittals shall be numbered sequentially, and the submittal numbers shall be clearly noted on the transmittal. Original submittals shall be assigned a numeric submittal number followed by a decimal point and a "1" to indicate it is an original (first) submittal. (For example, if submittal number 16.1 requires a resubmittal, that resubmittal will bear the designation "16.2". A further resubmittal would bear the designation "16.3", etc.

F. Disorganized submittals that do not meet the requirements of the Contract Documents will be returned without review.

G. Except as may otherwise be indicated, the ENGINEER will return email comments (in pdf format) of each submittal to the OWNER's RPR with comments noted thereon, within 14 calendar Days following receipt by the ENGINEER. The OWNER's RPR will compile all comments and return the complete submittal (in pdf format), within 21 calendar days following original receipt by the OWNER's RPR. It is considered reasonable that the CONTRACTOR will make a complete and acceptable submittal to the OWNER's RPR by the first resubmittal on an item. The OWNER reserves the right to withhold monies

due to the CONTRACTOR to cover additional costs of the ENGINEER's review beyond the first resubmittal. The ENGINEER's and OWNER RPR's combined maximum review period for each submittal or resubmittal will be 21 calendar Days. Thus, for a submittal that requires 2 resubmittals before it is complete, the maximum review period could be 63 calendar Days.

H. **Submittal Review Marking**

1. **NO EXCEPTIONS TAKEN.** If a submittal is returned to the CONTRACTOR marked "NO EXCEPTIONS TAKEN," formal revision and resubmission will not be required.
 2. **MAKE CORRECTIONS NOTED.** If a submittal is returned marked "MAKE CORRECTIONS NOTED," CONTRACTOR shall make the corrections on the submittal, but formal revision and resubmission will not be required.
 3. **REVISE-RESUBMIT.** If a submittal is returned marked "REVISE-RESUBMIT," the CONTRACTOR shall revise it and shall resubmit the required number of copies. Resubmittal of portions of multi-page or multi-drawing submittals will not be allowed. For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing noted as "REVISE - RESUBMIT," the submittal as a whole is deemed "REVISE - RESUBMIT," and all 10 drawings are required to be resubmitted.
 4. **REJECTED-RESUBMIT.** If a submittal is returned marked "REJECTED-RESUBMIT," it shall mean either that the proposed material or product does not satisfy the specification, the submittal is so incomplete that it cannot be reviewed, or is a substitution request not submitted in accordance with Section 01 60 00 - Products, Materials, Equipment, and Substitutions. In the first 2 cases, the CONTRACTOR shall prepare a new submittal and shall resubmit. In the latter case, the CONTRACTOR shall submit the substitution request according to Section 01 60 00.
- I. Resubmittal of rejected portions of a previous submittal will not be allowed. Every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal shall be identified and flagged on the resubmittal.
- J. Fabrication of an item may commence only after the ENGINEER has reviewed the pertinent submittals and returned copies to the CONTRACTOR marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED." Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as changes to the contract requirements.
- K. Submittals shall be carefully reviewed by an authorized representative of the CONTRACTOR prior to submission to the ENGINEER. Each submittal shall be dated and signed by the CONTRACTOR as being correct and in strict conformance with the Contract Documents. In the case of Shop Drawings, each sheet shall be so dated and signed. Any deviations from the Contract Documents shall be noted on the transmittal sheet. The ENGINEER will only review submittals that have been so verified by the CONTRACTOR. Non-verified submittals will be returned to the CONTRACTOR without action taken by the ENGINEER, and any delays caused thereby shall be the total responsibility of the CONTRACTOR.

- L. Corrections or comments made on the CONTRACTOR's Shop Drawings during review do not relieve the CONTRACTOR from compliance with Contract Drawings and Specifications. Review is for conformance to the design concept and general compliance with the Contract Documents only. The CONTRACTOR is responsible for confirming and correlating quantities and dimensions, fabrication processes and techniques, coordinating WORK with the trades, and satisfactory and safe performance of the WORK.

1.4 TECHNICAL MANUAL

- A. The CONTRACTOR shall submit technical operation and maintenance information for each item of mechanical, electrical, and instrumentation equipment in an organized manner in the Technical Manual. It shall be written so that it can be used and understood by the OWNER's operation and maintenance staff.

Organization. The Technical Manual shall be subdivided first by specification section number; second, by equipment item; and last, by "Category." The following "Categories" shall be addressed (as applicable):

1. **Category 1 - Equipment Summary**

- a. Summary: A table shall indicate the equipment name, equipment number, and process area in which the equipment is installed.
- b. Form: The ENGINEER will supply an Equipment Summary Form for each item of mechanical, electrical, and instrumentation equipment in the WORK. The CONTRACTOR shall fill in the relevant information on the form and include it in Part 1.

2. **Category 2 - Operational Procedures**

- a. Procedures: Manufacturer-recommended procedures on the following shall be included in Part 2:

Installation

Adjustment

Location of controls, special tools, equipment required, or related instrumentation needed for operation

Operation procedures

Shutdown

Troubleshooting

3. **Category 3 - Preventive Maintenance Procedures**

- a. Procedures: Preventive maintenance procedures shall include manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by maintaining the equipment in place.

- b. Schedules: Recommended frequency of preventive maintenance procedures shall be included. Lubrication schedules, including lubricant SAE grade, type, and temperature ranges, shall be covered.

4. Category 4 - Shop Drawings

- a. Drawings: This category includes approved shop or fabrication drawings with ENGINEER comments and corrections incorporated, complete with dimensions.

5. Category 5 – Documentation & Warrantees

- a. Equipment warranties, affidavits, certifications, calibrations, laboratory test results, etc. required by the Technical Specifications shall be placed in this category.

B. Format

1. Each Technical Manual shall be bound in standard size 3 ring hardcover binders labeled on the spine and cover with project name, OWNER's project number, specification section number, equipment name, and equipment identification number
2. Each Binder shall contain its own detailed table of contents at the front, plus a summary level table of contents information for the other binders in a multi-binder set.
3. Documents in binders shall be 3-hole punched, no text shall be punched out, and pages larger than 8-1/2 inches by 11-inches shall be folded to 8-1/2 inches by 11-inches. Binder ring size shall not exceed 2.5-inches in diameter.
4. Each final set of Technical Manuals shall include a CD with electronic files:
 - a. Project specific files created in Microsoft Office, AutoCad, Adobe Acrobat portable document format, or other software required by the specifications.
 - b. Manufacturer literature in Adobe Acrobat portable document format (pdf).

C. Technical Manual Review Process

1. The CONTRACTOR shall furnish three (3) draft Technical Manuals for each Specification Section that requires a Manual. The OWNER's RPR will retain one (1) copy, will forward one (1) copy to the OWNER, and will return one (1) copy to the CONTRACTOR with review comments.
2. The CONTRACTOR shall incorporate all comments into the draft and shall submit five (5) identical hard copies of the final Manual, bound in 3-ring binders, for acceptance.

D. Schedule

1. Except where indicated otherwise, Technical Manuals shall be submitted in final form to the OWNER's RPR not later than the 80 percent of construction completion

date. Discrepancies found by the OWNER or ENGINEER shall be corrected within 30 Days from the date of written notification by the OWNER's RPR.

1.5 SPARE PARTS LIST

- A. The CONTRACTOR shall furnish to the OWNER spare parts information for mechanical, electrical, and instrumentation equipment. The spare parts list shall include those spare parts that each manufacturer recommends be maintained by the OWNER in inventory.
 - 1. **Sources and Pricing:** The spare parts list shall include a current list price of each spare part. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet of spare parts to assist the OWNER in ordering.
 - 2. **Format:** The CONTRACTOR shall cross-reference spare parts lists to the equipment numbers designated in the Contract Documents. The spare parts lists shall be bound in standard size, 3 ring, loose-leaf, vinyl plastic hard cover binders suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches.

1.6 RECORD DRAWINGS

- A. The CONTRACTOR shall maintain one set of Drawings at the Site for the preparation of record drawings. On these, it shall mark every project condition, location, configuration, and any other change or deviation which may differ from the Contract Drawings at the time of award, including buried or concealed construction and utility features that are revealed during the course of construction. Special attention shall be given to recording the horizontal and vertical location of buried utilities that differ from the locations indicated, or that were not indicated on the Contract Drawings.
- B. The record drawings shall be supplemented by any detailed sketches as necessary or as CONTRACTOR is directed, to fully indicate the WORK as actually constructed. These record drawings are the CONTRACTOR's representation of as-built conditions, shall include revisions made by addenda and change orders, and shall be maintained up-to-date during the progress of the WORK. Red ink shall be used for alterations and notes. Notes shall identify relevant Change Orders by number and date.
- C. 11-inch x 17-inch size paper copies of the record drawings shall be submitted to the OWNER's RRP at 120 day intervals, starting after the date of the Notice to Proceed, and also at completion of WORK. Failure to submit complete record drawings on or before these dates will enact the liquidated damages clause for interim record drawing submittals described in Division 00 Contract Specifications.
- D. In the case of those drawings that depict the detail requirement for equipment to be assembled and fabricated in the factory, the record drawings shall be updated by indicating those portions which are superseded by change order drawings or final Shop Drawings, and by including appropriate reference information describing the change orders by number and the Shop Drawings by manufacturer, drawing, and revision numbers.
- E. Disorganized or incomplete record drawings will not be accepted. The CONTRACTOR shall revise them and resubmit the drawings for review.

- F. Record drawings shall be accessible to the OWNER's RPR during the construction period.
- G. Final payment will not be acted upon until the record drawings have been completed and delivered to the OWNER's RPR. Said up-to-date record drawings shall be in the form of a set of prints with carefully plotted information overlaid on the Contract Drawings.
- H. Information submitted by the CONTRACTOR will be assumed to be correct, and the CONTRACTOR shall be responsible for the accuracy of such information

1.7 QUALITY CONTROL (QC) SUBMITTALS

- A. Quality control submittals are defined as those required by the Specifications to present documentary evidence to the OWNER and ENGINEER that the CONTRACTOR has satisfied certain requirements of the Contract Documents.
- B. Unless otherwise indicated, QC submittals shall be submitted:
 - 1. Before delivery and unloading, for the following types of submittals:
 - a. Manufacturers' installation instructions
 - b. Manufacturers' and Installers' experience qualifications
 - c. Affidavits and manufacturers' certification of compliance with indicated product requirements
 - d. Laboratory analysis results
 - e. Factory test reports
 - f. Ready mix concrete delivery tickets
 - g. Design calculations
 - 2. Within 30 Days of the event documented for the following types of submittals:
 - a. Manufacturers' field representative certification of proper installation
 - b. Field measurement
 - c. Field test reports
 - d. Receipt of permit
 - e. Receipt of regulatory approval
- C. The OWNER's RPR and ENGINEER will record the date that a QC submittal was received and review it for compliance with submittal requirements, but the review procedures above for Shop Drawings and samples will not apply.

1.8 INFORMATIONAL SUBMITTALS

- A. Informational submittals, such as Requests for Information (RFI), Deviation Request (DR), Change Order Proposals (COR), etc. formalize the flow of information between the CONTRACTOR and the ENGINEER. The OWNER's standard forms will be employed for such purpose. Electronic copies of all standard Construction Management forms shall be provided by the OWNER to the CONTRACTOR.

1.9 CONSTRUCTION PHOTOGRAPHS

- A. The CONTRACTOR shall be responsible to take digital construction photographs, no less than once per week, showing the progress of the WORK, including documentation of all buried utilities encountered during construction as well as installation of new buried utilities and buried WORK required by the Contract.
- B. Upon completion of the WORK and before final payment, the CONTRACTOR shall electronically submit all photographs to the OWNER on a CD or other electronic media with each photograph's file name identified by location and date it was taken.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

SECTION 01 55 00 - SITE ACCESS AND STORAGE

PART 1 -- GENERAL

1.1 HIGHWAY LIMITATIONS

- A. 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 transportation and ingress and egress to the site of the WORK. It shall be the CONTRACTOR's responsibility to construct and maintain any haul roads required for its construction operations.

1.2 TEMPORARY CROSSINGS

- A. **General:** Continuous, unobstructed, safe, and adequate pedestrian and vehicular access shall be maintained for public use of Paris Canyon Road. Vehicular access to the City's chlorination building shall be maintained to the property line except when necessary construction precludes such access for reasonable periods of time.
- B. **Temporary Bridges:** Wherever necessary, to maintain vehicular crossings, the CONTRACTOR shall provide suitable temporary bridges or steel plates over unfilled excavations, except in such cases as the CONTRACTOR shall secure the written consent of the responsible individuals or authorities to omit such temporary bridges or steel plates, which written consent shall be delivered to the ENGINEER prior to excavation. Such bridges or steel plates shall be maintained in service until access is provided across the backfilled excavation. Temporary bridges or steel plates for street and highway crossing shall conform to the requirements of the authority having jurisdiction in each case, and the CONTRACTOR shall adopt designs furnished by said authority for such bridges or steel plates, or shall submit designs to said authority for approval, as may be required.
- C. **Street Use:** 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 hereunder, and it shall conduct its operations to not interfere unnecessarily with the authorized work of utility companies or other agencies in such streets, alleyways, or parking areas. No street shall be closed to the public without first obtaining permission of the ENGINEER and proper governmental authority. Where excavation is being performed in primary streets, one lane in each direction shall be kept open to traffic at all times unless otherwise indicated. Toe boards shall be provided to retain excavated material if required by the ENGINEER or the agency having jurisdiction over the street.
- D. **Traffic Control:** For the protection of traffic in public or private streets and ways, the CONTRACTOR shall provide, place, and maintain necessary barricades, traffic cones, warning signs, lights, and other safety devices in accordance with the requirements of Manual of Uniform Traffic Control Devices, Part VI - Traffic Controls for Street and Highway Construction and Maintenance Operations," published by U.S. Department of Transportation, Federal Highway Administration (ANSI D6.1).

1. The CONTRACTOR shall take necessary precautions for the protection of the WORK and the safety of the public. Barricades and obstructions shall be illuminated at night, and lights shall be kept burning from sunset until sunrise. The CONTRACTOR shall station such guards or flaggers and shall conform to such special safety regulations relating to traffic control as may be required by the public authorities within their respective jurisdictions.
 2. The CONTRACTOR shall submit three (3) copies of a traffic control plan to the City Engineer for approval a minimum of two (2) weeks prior to construction. The City Engineer shall be allowed access to observe these traffic control plans in use and to make any changes as field conditions warrant. Any changes required by the City Engineer shall supersede these plans and be done solely at the CONTRACTOR's expense.
 3. The CONTRACTOR shall remove traffic control devices when no longer needed, repair damage caused by installation of the devices, and shall remove post settings and backfill the resulting holes to match grade.
- E. **Temporary Street Closure:** If closure of any street is required during construction, the CONTRACTOR shall apply in writing to the City Engineer and any other jurisdictional agency at least 30 Days in advance of the required closure.
- F. **Temporary Driveway Closure:** The CONTRACTOR shall notify the owner or occupant (if not owner-occupied) of the closure of the driveways to be closed more than one 8 hour work day at least three (3) working days prior to the closure. The CONTRACTOR shall minimize the inconvenience and minimize the time period that the driveways will be closed. The CONTRACTOR shall fully explain to the owner/occupant how long the closure will take and when closure will start.

1.3 CONTRACTOR'S WORK AND STORAGE AREA

- A. The OWNER will designate and arrange for the CONTRACTOR's use, a portion of the property adjacent to the WORK for its exclusive use during the term of the Contract as a storage and shop area for its construction operations on the WORK. At completion of WORK, the CONTRACTOR shall return this area to its original condition, including grading and landscaping.
- B. The CONTRACTOR shall make its own arrangements for any necessary off-Site storage or shop areas necessary for the proper execution of the WORK.
- C. The CONTRACTOR shall construct and use a separate storage area for hazardous materials used in constructing the WORK.
 1. For the purpose of this paragraph, hazardous materials to be stored in the separate area are products labeled with any of the following terms: Warning, Caution, Poisonous, Toxic, Flammable, Corrosive, Reactive, or Explosive. In addition, whether or not so labeled, the following materials shall be stored in the separate area: diesel fuel, gasoline, new and used motor oil, hydraulic fluid, cement, paints and paint thinners, 2 part epoxy coatings, sealants, asphaltic products, glues, solvents, wood preservatives, sand blast materials, and spill absorbent.

2. Hazardous materials shall be stored in groupings according to the Material Safety Data Sheets.
3. The CONTRACTOR shall develop and submit to the ENGINEER a plan for storing and disposing of the materials above.
4. The CONTRACTOR shall obtain and submit to the ENGINEER a single EPA number for wastes generated at the Site.
5. The separate storage area shall meet the requirements of authorities having jurisdiction over the storage of hazardous materials.

1.4 PARKING

A. The CONTRACTOR shall:

1. Provide and maintain multiple temporary parking spots for CONTRACTOR employees, ENGINEER, OWNER, City and Government Representatives:
2. Traffic and parking areas shall be maintained in a sound condition, free of excavated material, construction equipment, mud, and construction materials. The CONTRACTOR shall repair breaks, potholes, low areas which collect standing water, and other deficiencies.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

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SECTION 01 56 10 - PROTECTION OF EXISTING FACILITIES

PART 1 -- GENERAL

1.1 GENERAL

- A. The CONTRACTOR shall protect all existing utilities and improvements not designated for removal and shall restore damaged or temporarily relocated utilities and improvements to a condition equal to or better than prior to such damage or temporary relocation, all in accordance with the Contract Documents.

1.2 RIGHTS-OF-WAY

- A. The CONTRACTOR shall not do any WORK that would affect any oil, gas, sewer, or water pipeline; any telephone, telegraph, or electric transmission line; any fence; or any other structure, nor shall the CONTRACTOR enter upon the rights-of-way involved until notified that the OWNER has secured authority therefor from the proper party.
- B. After authority has been obtained, the CONTRACTOR shall give said party due notice of its intention to begin work, if required by said party, and shall remove, shore, support, or otherwise protect such pipeline, transmission line, ditch, fence, or structure, or replace the same.

1.3 PROTECTION OF STREET OR ROADWAY MARKERS

- A. The CONTRACTOR shall not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. No pavement breaking or excavation shall be started until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced. Survey markers or points disturbed by the CONTRACTOR shall be accurately restored after street or roadway resurfacing has been completed.

1.4 EXISTING UTILITIES AND IMPROVEMENTS

- A. **General:** The CONTRACTOR shall protect underground Utilities and other improvements which may be impaired during construction operations, regardless of whether or not the Utilities are indicated on the Drawings. The CONTRACTOR shall take all possible precautions for the protection of unforeseen Utility lines to provide for uninterrupted service and to provide such special protection as may be necessary.
- B. Except where the Drawings indicate Utilities have been field located during design or certain Utility locations shall be exposed as part of the WORK, the CONTRACTOR shall be responsible for exploratory excavations as it deems necessary to determine the exact locations and depths of Utilities which may interfere with its work. All such exploratory excavations shall be performed as soon as practicable after Notice to Proceed and, in any event, a sufficient time in advance of construction to avoid possible delays to the CONTRACTOR's progress. When such exploratory excavations show the Utility location as shown on the Drawings to be in error, the CONTRACTOR shall so notify the ENGINEER.

- C. The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the Utility.
- D. **Utilities to be Moved:** In case it shall be necessary to move the property of any public utility or franchise holder, such utility company or franchise holder will, upon request of the CONTRACTOR, be notified by the OWNER to move such property within a specified reasonable time. When utility lines that are to be removed are encountered within the area of operations, the CONTRACTOR shall notify the ENGINEER a sufficient time in advance for the necessary measures to be taken to prevent interruption of service.
- E. **Utilities to be Removed:** Where the proper completion of the WORK requires the temporary or permanent removal and/or relocation of an existing Utility or other improvement which is indicated, the CONTRACTOR shall remove and, without unnecessary delay, temporarily replace or relocate such Utility or improvement in a manner satisfactory to the ENGINEER and the owner of the facility. In all cases of such temporary removal or relocation, restoration to the former location shall be accomplished by the CONTRACTOR in a manner that will restore or replace the Utility or improvement as nearly as possible to its former locations and to as good or better condition than found prior to removal.
- F. **OWNER's Right of Access:** The right is reserved to the OWNER and to the owners of public utilities and franchises to enter at any time upon any public street, alley, right-of-way, or easement for the purpose of making changes in their property made necessary by the WORK of this Contract.
- G. **Underground Utilities Indicated:** Existing Utility lines that are indicated or the locations of which are made known to the CONTRACTOR prior to excavation and that are to be retained, and all Utility lines that are constructed during excavation operations shall be protected from damage during excavation and backfilling and, if damaged, shall be immediately repaired or replaced by the CONTRACTOR, unless otherwise repaired by the owner of the damaged Utility. If the owner of the damaged facility performs its own repairs, the CONTRACTOR shall reimburse said owner for the costs of repair.
- H. **Underground Utilities Not Indicated:** In the event that the CONTRACTOR damages existing Utility lines that are not indicated or the locations of which are not made known to the CONTRACTOR prior to excavation, a verbal report of such damage shall be made immediately to the Utility and a written report thereof shall be made to the ENGINEER promptly thereafter. It shall be the responsibility of the CONTRACTOR to repair any damage in accordance with the associated Utility.
- I. **Approval of Repairs:** All repairs to a damaged Utility or improvement are subject to inspection and approval by an authorized representative of the Utility or improvement owner before being concealed by backfill or other work.
- J. **Maintaining in Service:** Unless indicated otherwise, oil and gasoline pipelines, power, and telephone or the communication cable ducts, gas and water mains, irrigation lines, sewer lines, storm drain lines, poles, and overhead power and communication wires and cables encountered along the line of the WORK shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the ENGINEER are made with the owner of said pipelines, duct, main, irrigation line, sewer, storm drain, pole, or wire or cable. The CONTRACTOR shall be responsible for

and shall repair all damage due to its operations, and the provisions of this Section shall not be abated even in the event such damage occurs after backfilling or is not discovered until after completion of the backfilling.

1.5 TREES OR SHRUBS WITHIN STREET RIGHTS-OF-WAY AND PROJECT LIMITS

- A. **General:** Except where trees or shrubs are indicated to be removed, the CONTRACTOR shall exercise all necessary precautions so as not to damage or destroy any trees or shrubs, including those lying within street rights-of-way and project limits, and shall not trim or remove any trees unless such trees have been approved for trimming or removal by the jurisdictional agency or OWNER. Existing trees and shrubs which are damaged during construction shall be trimmed or replaced by the CONTRACTOR or a certified tree company under permit from the jurisdictional agency and/or the OWNER. Tree trimming and replacement shall be accomplished in accordance with the following paragraphs.

1.6 LAWN AREAS

- A. Lawn or landscaped areas damaged during construction shall be repaired to match the pre-construction condition to the satisfaction of the landowner and the OWNER.

1.7 NOTIFICATION BY THE CONTRACTOR

- A. Prior to any excavation in the vicinity of any existing underground facilities, including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications, or television cables, the CONTRACTOR shall notify the respective authorities representing the owners or agencies responsible for such facilities not less than 3 Days nor more than 7 Days prior to excavation so that a representative of said owners or agencies can be present during such work if they so desire.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

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SECTION 01 60 00 - PRODUCTS, MATERIALS, EQUIPMENT AND SUBSTITUTIONS

PART 1 -- GENERAL

1.1 DEFINITIONS

- A. The word "Products," as used in the Contract Documents is defined to include purchased items for incorporation into the WORK, regardless of whether specifically purchased for the project or taken from CONTRACTOR's stock of previously purchased products. The word "Materials," is defined as products which must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, installed, or applied to form WORK. The word "Equipment" is defined as products with operational parts, regardless of whether motorized or manually operated, and particularly including products with service connections (wiring, piping, and other like items). Definitions in this paragraph are not intended to negate the meaning of other terms used in the Contract Documents, including "specialties," "systems," "structure," "finishes," "accessories," "furnishings," special construction," and similar terms, which are self-explanatory and have recognized meanings in the construction industry.
- B. Neither "Products" nor "Materials" nor "Equipment" includes machinery and equipment used for preparation, fabrication, conveying, and erection of the WORK.

1.2 QUALITY CONTROL

- A. **Source Limitations:** To the greatest extent possible for each unit of WORK, the CONTRACTOR shall provide products, materials, and equipment of a singular generic kind from a single source. All manufactured products shall meet the requirements of the Federal Buy American Act.
- B. **Compatibility of Options:** Where more than one choice is available as options for CONTRACTOR's selection of a product, material, or equipment, the CONTRACTOR shall select an option which is compatible with other products, materials, or equipment. Compatibility is a basic general requirement of product, material and equipment selections.
- C. **Manufactured Products:** All manufactured products installed as part of the WORK shall meet the Build America Buy America Act. Contractor shall submit documentation to the OWNER and ENGINEER for each manufactured product showing compliance with the Build America Buy America Act.

1.3 PRODUCT DELIVERY AND STORAGE

- A. The CONTRACTOR shall deliver and store the WORK in accordance with manufacturer's written recommendations and by methods and means which will prevent damage, deterioration, and loss including theft. Delivery schedules shall be controlled to minimize long-term storage of products at the Site and overcrowding of construction spaces. In particular, the CONTRACTOR shall ensure coordination to ensure minimum holding or storage times for flammable, hazardous, easily damaged, or sensitive materials to deterioration, theft, and other sources of loss.

1.4 TRANSPORTATION AND HANDLING

- A. Products shall be transported by methods to avoid damage and shall be delivered in undamaged condition in manufacturer's unopened containers and packaging.
- B. The CONTRACTOR shall provide equipment and personnel to handle products, materials, and equipment [including those furnished by OWNER,] by methods to prevent soiling and damage.
- C. The CONTRACTOR shall provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

1.5 STORAGE AND PROTECTION

- A. Products shall be stored in accordance with manufacturer's written instructions and with seals and labels intact and legible. Sensitive products shall be stored in weather-tight climate controlled enclosures and temperature and humidity ranges shall be maintained within tolerances required by manufacturer's recommendations.
- B. For exterior storage of fabricated products, products shall be placed on sloped supports above ground. Products subject to deterioration shall be covered with impervious sheet covering and ventilation shall be provided to avoid condensation.
- C. Loose granular materials shall be stored on solid flat surfaces in a well-drained area and shall be prevented from mixing with foreign matter.
- D. Storage shall be arranged to provide access for inspection. The CONTRACTOR shall periodically inspect to assure products are undamaged and are maintained under required conditions.
- E. Storage shall be arranged in a manner to provide access for maintenance of stored items and for inspection.

1.6 MAINTENANCE OF PRODUCTS IN STORAGE

- A. Stored products shall be periodically inspected on a scheduled basis. The CONTRACTOR shall maintain a log of inspections and shall make the log available on request.
- B. The CONTRACTOR shall comply with manufacturer's product storage requirements and recommendations.
- C. The CONTRACTOR shall maintain manufacturer-required environmental conditions continuously.
- D. The CONTRACTOR shall ensure that surfaces of products exposed to the elements are not adversely affected and that weathering of finishes does not occur.
- E. For mechanical and electrical equipment, the CONTRACTOR shall provide a copy of the manufacturer's service instructions with each item and the exterior of the package shall contain notice that instructions are included.

- F. Products shall be serviced on a regularly scheduled basis, and a log of services shall be maintained and submitted as a record document prior to final acceptance by the OWNER in accordance with the Contract Documents.

1.7 PROPOSED SUBSTITUTIONS OR "OR-EQUAL" ITEM

- A. Whenever materials or equipment are indicated in the Contract Documents by using the name of a proprietary item or the name of a particular manufacturer, the naming of the item is intended to establish the type, function, and quality required. If the name is followed by the words "or equal" indicating that a substitution is permitted, materials or equipment of other manufacturers may be accepted if sufficient information is submitted by the CONTRACTOR to allow the ENGINEER to determine that the material or equipment proposed is equivalent or equal to that named, subject to the following requirements:

1. The burden of proof as to the type, function, and quality of any such substitution product, material or equipment shall be upon the CONTRACTOR.
2. The ENGINEER will be the sole judge as to the type, function, and quality of any such substitution and the ENGINEER's decision shall be final.
3. The ENGINEER may require the CONTRACTOR to furnish additional data about the proposed substitution.
4. The OWNER may require the CONTRACTOR to furnish a special performance guarantee or other surety with respect to any substitution.
5. Acceptance by the ENGINEER of a substitution item proposed by the CONTRACTOR shall not relieve the CONTRACTOR of the responsibility for full compliance with the Contract Documents and for adequacy of the substitution.
6. The CONTRACTOR shall pay all costs of implementing accepted substitutions, including redesign and changes to WORK necessary to accommodate the substitution.

- B. The procedure for review by the ENGINEER will include the following:

1. If the CONTRACTOR wishes to provide a substitution item, the CONTRACTOR shall make written application to the ENGINEER on the "Substitution Request Form."
2. Unless otherwise provided by law or authorized in writing by the ENGINEER, the "Substitution Request Form(s)" shall be submitted within the 35 Day period after award of the Contract.
3. Wherever a proposed substitution item has not been submitted within said 35 Day period, or wherever the submission of a proposed substitution material or equipment has been judged to be unacceptable by the ENGINEER, the CONTRACTOR shall provide the material or equipment indicated in the Contract Documents.

4. The CONTRACTOR shall certify by signing the form that the list of paragraphs on the form are correct for the proposed substitution.
 5. The ENGINEER will evaluate each proposed substitution within a reasonable period of time.
 6. As applicable, no shop drawing submittals shall be made for a substitution item nor shall any substitution item be ordered, installed, or utilized without the ENGINEER'S prior written acceptance of the CONTRACTOR'S "Substitution Request Form."
 7. The ENGINEER will record the time required by the ENGINEER in evaluating substitutions proposed by the CONTRACTOR and in making changes by the CONTRACTOR in the Contract Documents occasioned thereby.
- C. The CONTRACTOR's application shall address the following factors which will be considered by the ENGINEER in evaluating the proposed substitution:
1. Whether the evaluation and acceptance of the proposed substitution will prejudice the CONTRACTOR's achievement of Substantial Completion on time.
 2. Whether acceptance of the substitution for use in the WORK will require a change in any of the Contract Documents to adapt the design to the proposed substitution.
 3. Whether incorporation or use of the substitution in connection with the WORK is subject to payment of any license fee or royalty.
 4. Whether all variations of the proposed substitution from the items originally specified are identified.
 5. Whether available maintenance, repair, and replacement service are indicated. The manufacturer shall have a local service agency (within 50 miles of the site) which maintains properly trained personnel and adequate spare parts and is able to respond and complete repairs within 24 hours.
 6. Whether an itemized estimate is included of all costs that will result directly or indirectly from acceptance of such substitution, including cost of redesign and claims of other contractors affected by the resulting change.
 7. Whether the proposed substitute item meets or exceeds the experience and/or equivalency requirements listed in the appropriate technical specifications.
- D. Without any increase in cost to the OWNER, the CONTRACTOR shall be responsible for and pay all costs in connection with proposed substitutions and of inspections and testing of equipment or materials submitted for review prior to the CONTRACTOR's purchase thereof for incorporation in the WORK, whether or not the ENGINEER accepts the proposed substitution or proposed equipment or material. The CONTRACTOR shall reimburse the OWNER for the charges of the ENGINEER for evaluating each proposed substitution.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

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SECTION 01 75 00 - STARTUP

PART 1 -- GENERAL

1.1 GENERAL

- A. System startup is prerequisite to satisfactory completion of the contract requirements and shall be completed within the Contract Times.
- B. Conduct all test, check out, startup, and related requirements indicated in the Contract Documents and provide documentation of same to the ENGINEER prior to requesting Substantial Completion from the ENGINEER. Where manufacturer onsite inspections are required before startup, the manufacturer shall furnish a written statement that the installation and check out is complete and proper and that the item(s) are ready for startup
- C. The CONTRACTOR shall be responsible for coordinating all parties for a successful startup: the ENGINEER and OWNER will be available for technical and operational advice prior to and during startup.
- D. General requirements for startup activities are included in this Section. More specific requirements may also be included in other portions of the Contract Documents.
- E. Temporary facilities may be necessary. If so, CONTRACTOR shall design, provide, operate, and later decommission them.

1.2 DEFINITIONS

- A. Startup is defined as testing, demonstrations, and other activities as required to achieve Substantial Completion. Startup includes pre-commissioning and commissioning activities, manufacturer's services, certifications of readiness for testing, and troubleshooting, checkout, and shakedown activities.
- B. Pre-commissioning is the systematic demonstration through testing and extended operation that major equipment operate properly and consistent with their intended function. Pre-commissioning involves balancing, adjustments, and calibration. Pre-commissioning will not be considered complete until successful results and documentation of tests and manufacturer's certifications required by the Contract Documents are submitted and accepted by the ENGINEER. Pre-commissioning of all portions of the WORK shall be successfully completed prior to starting Commissioning.
- C. Commissioning is the verification that the complete WORK functions on an extended basis in full conformance with the Contract requirements.

1.3 SUBMITTALS

- A. **Schedule:** The schedule for startup shall be coordinated with the OWNER, Paris Relief and Southfield Ditch representatives, PacifiCorp representatives, and the local water-master.

- B. **Startup Plan:** Not less than 30 Days prior to startup, submit for review a detailed Startup Plan. The CONTRACTOR shall revise the Plan as necessary based on review comments. The Plan shall include:
1. Schedules for manufacturers' equipment certifications
 2. Schedules for submitting final Technical Manuals,
 3. Schedule for training the OWNER's personnel,
 4. Description of temporary facilities and schedule for installation and decommissioning them
 5. List of OWNER and CONTRACTOR-furnished supplies
 6. Detailed schedule of operations to achieve successful pre-commissioning and commissioning.
 7. Checklists and data forms for each item of equipment
 8. Address coordination with the OWNER's staff.
 9. Designate a representative of the CONTRACTOR who has the authority to act in matters relating to startup and has experience in testing rotating drum screen facilities and pipelines. The Plan shall also designate the roles and responsibilities of any Subcontractors that may be involved in startup activities.
 10. Safety, startup, and testing procedures and proposed inspection and certification forms and records.
 11. Hydrostatic testing of water-holding structures and pipelines and other potable water equipment.
- C. **System Outage Requests:** Request for shutdown of existing systems as necessary to test or start up new facilities.
- D. **Records and Documentation:**
1. Where required by the specifications, submit equipment installation certifications under those sections.
 2. Records of startup as indicated below.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 MALFUNCTIONS

- A. During system startup and testing, any malfunctioning equipment or project component shall be identified and repaired. Upon completion of repair(s), the system shall be retested to insure proper functionality under all operational scenarios.
- B. The CONTRACTOR shall arrange for manufacturer's representatives to visit the Site as often as necessary to correct equipment malfunctions.

3.2 PREREQUISITES

- A. The following shall be completed before pre-commissioning begins.
 - 1. All Technical Manual information required by the Contract Documents has been submitted.
 - 2. Devices and equipment shall be fully functional, adjusted, and tested.
 - 3. Manufacturer's certifications of proper installation have been accepted.
 - 4. Leakage tests, electrical tests, and adjustments have been completed.
 - 5. The ENGINEER has approved the Startup Plan.
 - 6. Temporary facilities are functional, adjusted, and ready for use.

3.3 GENERAL

3.4 PRE-COMMISSIONING

- A. The CONTRACTOR shall test individual system components for proper functionality and water tightness, where applicable. Items of equipment shall be tested as part of a system to the maximum extent possible.

3.5 COMMISSIONING

- A. The CONTRACTOR shall start up the irrigation diversion structure and operate it without malfunction for a continuous 2 Day, 24 hour/day period. The ENGINEER will determine the operational parameters.
- B. Defects that appear shall be promptly corrected.
- C. Commissioning shall not begin until leakage tests, instrumentation tests and adjustments, electrical tests and adjustments, equipment field tests, and system tests have been completed to the satisfaction of the ENGINEER.

D. During commissioning, the CONTRACTOR shall:

1. Assist irrigation company employees with system adjustments and operational scenario trials.
2. Review maintenance and operation procedures.

- END OF SECTION -

SECTION 01 77 00 - PROJECT CLOSEOUT

PART 1 -- GENERAL

1.1 FINAL CLEANUP

- A. The CONTRACTOR shall promptly remove from the vicinity of the completed WORK, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the WORK by the OWNER will be withheld until the CONTRACTOR has satisfactorily performed the final cleanup of the Site.

1.2 CLOSEOUT TIMETABLE

- A. The CONTRACTOR shall establish dates for equipment testing, acceptance periods, and on-site instructional periods (as required under the Contract). Such dates shall be established not less than one week prior to beginning any of the foregoing items, to allow the OWNER, the ENGINEER, and their authorized representatives sufficient time to schedule attendance at such activities.

1.3 TECHNICAL MANUAL SUBMITTAL

- A. The CONTRACTOR's attention is directed to the condition that [one] percent of the Contract Price will be retained from any monies due the CONTRACTOR as progress payments, if at the 75 percent construction completion point, the approved Technical Manual complying with Section 01 33 00 has not been submitted. The aforementioned amount will be retained by the OWNER as the agreed, estimated value of the approved Technical Manual.

1.4 FINAL SUBMITTALS

- A. The CONTRACTOR, prior to requesting final payment, shall obtain and submit the following items to the ENGINEER for transmittal to the OWNER:
 - 1. Written guarantees, where required.
 - 2. Technical Manuals and instructions.
 - 3. New permanent cylinders and key blanks for all locks.
 - 4. Maintenance stock items; spare parts; special tools.
 - 5. Completed record drawings.
 - 6. Bonds for maintenance, etc., as required.
 - 7. Certificates of inspection and acceptance by local governing agencies having jurisdiction.

8. Releases from all parties who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.

1.5 MAINTENANCE AND GUARANTEE

- A. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing constructed by the CONTRACTOR which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless the CONTRACTOR shall have obtained a statement in writing from the affected private owner or public agency releasing the OWNER from further responsibility in connection with such repair or resurfacing.
- B. The CONTRACTOR shall make all repairs and replacements promptly upon receipt of written order from the OWNER. If the CONTRACTOR fails to make such repairs or replacements promptly, the OWNER reserves the right to do the WORK and the CONTRACTOR and its surety shall be liable to the OWNER for the cost thereof.

1.6 BOND

- A. The CONTRACTOR shall provide a bond to guarantee performance of the provisions contained in Paragraph "Maintenance and Guarantee" above, and Article 13 of the General Conditions.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

SECTION 02 22 00 - SITE CONDITIONS SURVEYS

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall conduct thorough pre-construction and post-construction Site conditions surveys of the entire Project. Site conditions surveys shall consist of photographs and topographic survey of existing features. The purpose of the Site conditions survey is to document any changes to the design as well as document the replacement and or repair of any existing infrastructure affected by the Work.

1.2 CONTRACTOR SUBMITTALS

- A. Photographs, and other data of the preconstruction conditions shall be submitted to the ENGINEER for record purposes prior to, but not more than three weeks before, commencement of any construction activities.
- B. CONTRACTOR shall maintain a set of As-Built drawings documenting any changes to the design including (but not limited to): change in location or alignment of major work elements (structures, fencing, gates, pipe alignment, etc.). As-built drawings shall be submitted to the ENGINEER upon closeout of the Project.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 PHOTOGRAPHS

- A. CONTRACTOR, as a minimum, shall document pre- and post-construction conditions by preparing videotape surveys of the following:
 - 1. Roadways used to access the Site or haul materials and equipment to the Site.
 - 2. Work areas, including actual work sites, materials processing and stockpiling areas, access corridors, disposal areas, and staging areas.
 - 3. Any work completed by other contractors at the Site that will be connected to or otherwise affected by the WORK.
 - 4. Driveways, fences, repair of existing utility lines, and buildings which might be affected by the WORK.
- B. Photographs and spot elevation surveys shall thoroughly document the original condition and location of existing features and facilities.

3.2 AS-BUILT DRAWINGS

- A. Where construction of the WORK elements deviates from the design documents, the contractor shall document the changes to the design as-built on a single plan set.

Markups shall clearly identify the as-built condition including location, material, product substitution, final grade elevations, etc.,

- B. As-built drawings shall be submitted to the ENGINEER in either hard copy (with hand written markups) or PDF. All markups shall be drawn in red ink (or red linework if documented electronically).

- END OF SECTION -

SECTION 02 41 00 – DEMOLITION, SALVAGE, AND REHABILITATION

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall demolish and reconstruct existing civil, landscaping and structural facilities as indicated, in accordance with the Contract Documents.

1.2 COORDINATION

- A. The CONTRACTOR shall carefully coordinate the WORK in areas where existing infrastructure will be impacted by completion of the WORK and where existing facilities remain operational. The WORK as indicated is not all inclusive, and the CONTRACTOR shall be responsible for performing the reconstruction indicated plus that which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be demolished and reconstructed, but existing utilities such as water, chemicals, drainage, and electrical wiring are not necessarily shown.
- B. The CONTRACTOR shall note that the Drawings used to indicate demolition and reconstruction are based on record drawings of the existing facilities. These record drawings have been reproduced to show existing conditions and to clarify the scope of WORK as much as possible. Prior to bidding, the CONTRACTOR shall conduct a comprehensive survey at the Site to verify the correctness and exactness of the Drawings, the scope of WORK, and the extent of existing utilities.
- C. While demolition and reconstruction are being performed, the CONTRACTOR shall provide adequate access for the continued operation and maintenance of private property and adjacent utilities. The CONTRACTOR shall erect and maintain fences, warning signs, barricades, and other devices around the reconstruction as required for the protection of the CONTRACTOR's employees, the public, private land owner's, and utility workers. The CONTRACTOR shall remove such protection when reconstruction activities are complete, or as work progresses, or when directed by the ENGINEER.

1.3 CONTRACTOR SUBMITTALS

- A. Demolition and reconstruction activities and procedures, including operational sequence, shall be submitted to the ENGINEER for approval. The procedures shall provide for safe conduct of the WORK, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation. A storage plan for salvaged items shall be included.

1.4 DEMOLITION

- A. Existing structures, equipment, piping, valves, utilities, and related appurtenances such as anchors, supports, and hardware indicated or required to be demolished as part of

the WORK shall be removed and disposed of unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Removed items shall be disposed of offsite by the CONTRACTOR.

B. Items to be removed include:

Item	Description
Diversion Structure	Abandoned Concrete diversion structure located on private property adjacent to Paris Creek near river Station 5+75. See sheet C100
(Phase II) Tailrace Flume	Existing ~50' long by 5' wide concrete tailrace flume with sluice gates, and grating. Demolition shall include removal of all adjacent concrete and abandoned concrete structures. DEMOLITION OF THE PARIS HYDRO TAILRACE STRUCTURE SHALL ONLY PROCEED WITH WRITTEN APPROVAL FROM PACIFICORP REPRESENTATIVE. DEMOLITION OF TAILRACE SHALL NOT INTERRUPT PARIS RELIEF OR SOUTHFIELD DITCH IRRIGATION WATER SUPPLY SERVICE DURING THE IRRIGATION PERIOD.
Existing Abandoned piping	Where existing abandoned piping is uncovered during installation of new 30" waterline, the Contractor may remove or abandon in place. Any existing pipe material abandoned in place shall not conflict with trench construction or backfill.

1.5 RELOCATION

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances required to be relocated shall be removed without any degradation in condition from that prior to removal. The CONTRACTOR shall be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.

B. Items to be relocated include:

Item	Description
City of Paris chlorination building	If the new C905 irrigation water supply line

<p>pipings</p>	<p>conflicts with underground piping and communication lines to the existing City Chlorination building, the Contractor shall relocate the piping around the irrigation line. Relocation of the City's pipelines shall be completed with approval from City representatives. Relocation of City utility lines shall be documented in accordance with Specification Section 02 22 00 Site Condition Surveys.</p>
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1.6 REHABILITATION

- A. Existing civil, landscaping, structural, architectural, mechanical, electrical, and instrumentation WORK disturbed or damaged by reconstruction activities shall be repaired and rehabilitated as indicated.
- B. Damaged items shall be repaired or replaced with new items to restore items or surfaces to a condition equal to and matching that existing prior to damage.

1.7 DISPOSAL

- A. The CONTRACTOR shall be responsible for the offsite disposal of debris resulting from reconstruction in compliance with local, state, and federal codes and requirements.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 GENERAL

- A. The CONTRACTOR shall coordinate demolition and reconstruction WORK with the OWNER and ENGINEER. Unless otherwise indicated, the CONTRACTOR shall be responsible for the sequence of activities. WORK shall be performed in accordance with applicable safety rules and regulations.
- B. The CONTRACTOR shall verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and reconstruction.
- C. The CONTRACTOR shall take precautions to avoid damage to adjacent facilities and to limit the WORK activities to the extent indicated. If reconstruction beyond the scope indicated is required, the CONTRACTOR shall obtain approval from the ENGINEER prior to commencing.

3.2 PROTECTION OF EXISTING FACILITIES

- A. Before beginning any reconstruction, the CONTRACTOR shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent

of reconstruction and coordination with the WORK. Existing facilities not subject to reconstruction shall be protected and maintained in accordance with Section 01 56 10 - Protection of Existing Facilities. Damaged existing facilities shall be repaired to the previous condition or replaced.

- B. Persons shall be afforded safe passages around areas of demolition.
- C. Structural elements shall not be overloaded. The CONTRACTOR shall be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of WORK performed under this Section. The CONTRACTOR shall remove temporary protection when the WORK is complete or when so authorized by the ENGINEER.
- D. The CONTRACTOR shall carefully consider bearing loads and capacities before placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the CONTRACTOR shall consult with the ENGINEER prior to the placement of such equipment or material.

3.3 DEMOLITION, SALVAGE, AND RELOCATION

- A. The Contract Documents indicate existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utilities including such services as water, chemicals, drainage, electrical wiring, controls, and instrumentation are not necessarily indicated. The CONTRACTOR shall verify the scope of the WORK to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation. The removal of existing facilities for demolition, salvage, and relocation shall include the following requirements:
 - 1. Equipment supports, including concrete pads, baseplates, mounting bolts, and support hangers, shall be removed. Damage to the existing structure shall be repaired as indicated.
 - 2. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.
 - 3. Below-grade areas and voids resulting from demolition of structures shall be completely filled. Fill and compaction shall be in accordance with Section 31 00 00 - Earthwork. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as indicated.
 - 4. When existing pipe is removed, the CONTRACTOR shall plug the resulting open ends whether or not so indicated. Where removed piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug.
- B. The CONTRACTOR shall perform a functional test of existing equipment that is relocated and reinstalled to ensure the equipment functions in the manner documented during the initial inspection. The CONTRACTOR shall inform the ENGINEER in writing a minimum of 5 Days prior to the functional testing in order for the OWNER and ENGINEER to witness the test. If, in the opinion of the ENGINEER, the relocated equipment does not function in a satisfactory manner, the CONTRACTOR shall make repairs and modifications necessary to restore the equipment to its original operating condition at no additional cost to the OWNER.

3.4 ABANDONMENT

- A. Existing facilities to be abandoned shall be prepared as indicated. Where existing buried piping is to be abandoned, the CONTRACTOR shall remove the abandoned pipe for a distance of 5-feet from any connecting structures. Openings at the existing structures shall be repaired. The remaining pipe shall be capped or crushed at both ends prior to backfill.

3.5 REHABILITATION

- A. Certain areas of existing structures, piping, conduits, and the like will be affected by WORK necessary to complete modifications under this Contract. The CONTRACTOR shall be responsible to rehabilitate those areas affected by its construction activities.
- B. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection. Any damage to the lining and coating of the existing piping shall be repaired. Dielectric insulating joints shall be installed at interconnections between new and existing piping.
- C. Where existing equipment, piping, and supports, electrical panels and devices, conduits, and associated appurtenances are removed, the CONTRACTOR shall rehabilitate the affected area such that little or no evidence of the previous installation remains. Openings in concrete floors, walls, and ceilings from piping, conduit, and fastener penetrations shall be filled with non-shrink grout and finished to match the adjacent area. Concrete pads, bases associated with equipment, supports, and appurtenances shall be removed by chipping away concrete and cutting any exposed reinforced steel and anchor bolts a minimum of 2-inches below finished grade and be painted with epoxy paint. The area of concrete to be rehabilitated shall be scored by saw cutting clean, straight lines to a minimum depth of 1.5-inches, and concrete within the scored lines removed to a depth of 1.5-inches (or the depth of cover over reinforcing steel, whichever is less). The area within the scored lines shall be patched with non-shrink grout to match the adjacent grade and finish. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit.
- D. Where reconstruction activities damage the painting and coating of adjacent or nearby facilities, the damaged areas shall be surface prepared and coated in accordance with Section 09 96 00 - Protective Coating to match the original painting and coating with a compatible system. Surfaces of equipment items that are to be relocated shall be prepared and be coated in accordance with Section 09 96 00 - Protective Coating.

3.6 DISPOSAL

- A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities which shall not be closed or obstructed without permission from the OWNER. Alternate routes shall be provided around closed or obstructed traffic ways.
- B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these

structures shall remain prior to placing of backfill in the areas from which structures were removed.

- C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

3.7 OCCUPANCY AND POLLUTION CONTROL

- A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. The CONTRACTOR shall comply with government regulations pertaining to environmental protection.
- B. Water shall not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

3.8 CLEANING

- A. During and upon completion of WORK, the CONTRACTOR shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by WORK in a clean, approved condition.
- B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as directed by the ENGINEER or governing authorities, and adjacent areas shall be returned to condition existing prior to start of WORK.

- END OF SECTION -

SECTION 31 05 19 - GEOTEXTILES

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide geotextiles, complete and in place, in accordance with the Contract Documents.
- B. **Definitions:** The following definitions apply to the WORK of this Section:
1. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.
 2. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile provided.
 3. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile provided.
 4. Nondestructive Sample: Sample representative of finished geotextile, prepared for testing without destruction of geotextile.
 5. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.
 6. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D 4884.
 7. Woven geotextile: A geotextile fabric composed of polymeric yarn interlaced to form a planar structure with uniform weave pattern.
 8. Nonwoven geotextile: A geotextile fabric composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. The following standards are referenced in this Section:

ASTM D 4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D 4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method

ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4884	Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Sewn Geotextiles
ASTM D 4886	Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method)

1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
- B. Shop Drawings
 - 1. Manufacturer material specifications and product literature.
 - 2. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.
 - 3. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.
- C. Samples
 - 1. Geotextile: One-piece, minimum 18-inches long, taken across full width of roll of each type and weight of geotextile. Label each with brand name and furnish documentation of lot and roll number from which each sample was obtained.
 - 2. Field Sewn Seam: 5-foot length of seam, 12-inches wide with seam along center, for each type and weight of geotextile.
 - 3. Securing Pin and Washer: 1 each.
- D. Certifications
 - 1. Certification from geotextile manufacturer that products satisfy the indicated requirements.
 - 2. Field seam efficiency test results.

PART 2 -- PRODUCTS

2.1 NONWOVEN GEOTEXTILE

- A. Nonwoven geotextile shall be composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern. Products shall be calendared or finished so that yarns will retain their relative position with respect to each other.
- B. Polymeric yarn shall be long-chain synthetic polymers (polyester, polypropylene, or polyethylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.
- C. **Geotextile Edges:** Selvaged or finished to prevent outer material from separating from sheet.
- D. **Unseamed Sheet Width:** Minimum 6-feet.
- E. **Nominal Weight per Square Yard:** 12 ounces.
- F. **Physical Properties:** Conform to requirements below.

PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE		
Property	Requirement	Test Method
Apparent Opening Size (AOS)	No. 100 to No. 140 U.S. Standard Sieve Size	ASTM D 4751
Water Permittivity	1.2 sec. ⁻¹ , MinARV	ASTM D 4491 (Falling Head)
Vertical Waterflow Rate	90 gpm/sq ft, MinARV	
Wide Width Strip Tensile Strength	300 MinARV	ASTM D 4595
Wide Width Strip Elongation	70 percent, MaxARV	ASTM D 4595
Trapezoidal Tear Strength	120 lb, MinARV	ASTM D 4533
Puncture Strength	130 lb, MinARV	ASTM D 4833
Ultraviolet Radiation Resistance	90 percent strength retention, MinARV after 500 hours	ASTM D 4355

2.2 SEWING THREAD

- A. Sewing thread shall be polypropylene, polyester, or Kevlar thread with durability equal to or greater than durability of geotextile sewn.

2.3 SECURING PINS

- A. Securing pins shall be steel rods or bars conforming to the following:

1. 3/16-inch diameter.
2. Pointed at one end; head on other end, sufficiently large to retain washer.
3. Minimum Length: 12-inches.

- B. Steel washers for securing pins shall be:

1. Outside Diameter: Not less than 1-1/2 inches.
2. Inside Diameter: 1/4-inch.
3. Thickness: 1/8-inch.

- C. Steel Wire Staples

1. U-shaped.
2. 10-gauge.
3. Minimum 6-inches long.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver each roll with sufficient information attached to identify manufacturer and product name or number.
- B. Handle products in manner that maintains undamaged condition.
- C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in a way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

3.2 LAYING GEOTEXTILE

- A. Notify the ENGINEER whenever geotextiles are to be placed. Do not place geotextile prior to obtaining ENGINEER's approval of underlying materials.

- B. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

3.3 ORIENTATION ON SLOPES

- A. Orient geotextile with long dimension of each sheet parallel to direction of slope.
- B. Geotextile may be oriented with long dimension of sheet transverse to direction of slope only if sheet width, without unsewn seams, is sufficient to cover entire slope and anchor trench and extend at least 18-inches beyond toe of slope.

3.4 JOINTS

A. Unseamed Joints

1. Unseamed joints shall be overlapped to the following dimensions unless otherwise indicated:
 - a. Foundation/Subgrade Stabilization: Minimum 18-inches.
 - b. Riprap: Minimum 18-inches.
 - c. Drain Trenches: Minimum 18-inches, except overlap shall equal trench width if trench width is less than 18-inches.
 - d. Other Applications: Minimum 12-inches.

- B. Sewn seams shall be used wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by ENGINEER, also may be used instead of overlap at joints for applications that do not require stress transfer.

1. Seam efficiency shall be minimum 70 percent, verified by preparing and testing minimum of one set of nondestructive samples per acre of each type and weight of geotextile provided. Test according to ASTM D 4884.
2. Type: "J" type seams are preferred, but flat or butterfly seams are acceptable.
3. Stitch Count: Minimum 3 to maximum 7 stitches per inch.
4. Stitch Type: Double-thread chainstitch, Type 401, Federal Standard No. 751a.
5. Stitch Location: 2-inches from geotextile sheet edges, or more if necessary to develop required seam strength.
6. Sewing Machines: Capable of penetrating 4 layers of geotextile.

3.5 SECURING GEOTEXTILE

- A. Secure geotextile during installation as necessary with sandbags or other means approved by ENGINEER.
- B. Securing Pins

1. Insert securing pins with washers through geotextile, midway between edges of overlaps and 6-inches from free edges.
2. Spacing

Slope	Maximum Pin Spacing, feet
Steeper than 3:1	2
3:1 to 4:1	3
Flatter than 4:1	5

3. Pins shall not be installed on rock vane hydraulic structures.
4. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.
5. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.

3.6 PLACING PRODUCTS OVER GEOTEXTILE

- A. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as indicated below.

3.7 RIPRAP APPLICATIONS

- A. Overlap geotextile at each joint with upstream sheet of geotextile overlapping downstream sheet.
- B. Sew joints where wave runup may occur.

3.8 GEOTEXTILE-REINFORCED EARTH WALL APPLICATIONS

- A. Sew exposed joints; extend sewn seams minimum 3-feet behind face of wall.
- B. Protect exposed geotextile from damage and deterioration until permanent facing is applied.

3.9 SILT FENCE APPLICATIONS

- A. Install geotextile in one piece or continuously sewn to make one piece, for full length and height of fence, including portion of geotextile buried in toe trench.
- B. Install bottom edge of sheet in toe trench and backfill in a way that securely anchors geotextile in trench.

- C. Securely fasten geotextile to a wire mesh backing and each support post in a way that will not result in tearing of geotextile when fence is subjected to service loads.
- D. Promptly repair or replace silt fence that becomes damaged.

3.10 REPAIRING GEOTEXTILE

- A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile. Repair damaged geotextile by placing patch of undamaged geotextile over damaged area plus at least 18-inches in all directions beyond damaged area. Remove interfering material as necessary to expose damaged geotextile for repair. Sew patches or secure them with pins and washers, as indicated above for securing geotextile, or by other means approved by ENGINEER.

- END OF SECTION -

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SECTION 03 11 13 - CONCRETE FORMWORK

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall design and furnish all concrete formwork, and associated bracing, shoring, and supports for cast-in-place concrete, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
- B. **Manufacturer's information.** Manufacturer's information demonstrating compliance with requirements for the formwork materials, including, but not limited to:
 - 1. Form release agent, including NSF certification if not using mineral oil.

1.3 QUALITY CONTROL

- A. **Tolerances:** The variation from required lines or grade shall not exceed 1/4-inch in 10-feet, non-cumulative, and there shall be no offsets or visible waviness in the finished surface. Other tolerances shall be within the tolerances of ACI 117 - Standard Tolerances for Concrete Construction and Materials

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Form materials shall not adversely affect the concrete.
- B. Forms shall be tight so as to prevent the loss of water, cement, and fines.
- C. **NSF-61 Compliance.** Form materials that may remain or leave residues on or in the concrete shall be certified as compliant with NSF Standard 61 – Drinking Water System Components.

2.2 DESIGN

- A. **Design Responsibility.** The CONTRACTOR shall assume full responsibility for the adequate design of formwork and falsework.
 - 1. The design of concrete forms, falsework, and shoring shall comply with applicable local, state, and Federal regulations.
- B. **Formwork Design.** The following criteria shall be satisfied during the placement of concrete, the subsequent vibration of the freshly-placed concrete, and the curing period prior to the planned removal of the forms:

1. Forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape.
2. Forms shall be properly braced or tied together to maintain their position and shape. If adequate foundation for shores cannot be secured, trussed supports shall be provided.
3. Suitable and effective means shall be provided for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete.
4. **Chamfer Edges.** Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-inch chamfers or be tooled to 0.5-inch radius. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.
5. **Clean-out Holes.** Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the ENGINEER.

C. **Wall forms.** Specific to the design of wall forms, the following additional criteria shall be met:

1. **Gaskets.** The forms shall be tight so as to prevent the loss of water, cement, and fines. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1.0- to 1.5-inch diameter polyethylene rod held in position to the underside of the wall form.
2. **Form Windows.** Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03 30 00 - Cast-in-Place Concrete. The size, number, and location of such form windows shall be as acceptable to the ENGINEER.
3. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete.

2.3 FORMWORK MATERIALS

A. **Form Materials.** Forms shall be smooth surface forms and shall be of the following materials:

Concrete Element:	Form Material:
Walls	Steel, fiberglass, or plywood panel
Columns	Steel, plywood or fiberglass

Roof and Floor Slabs	Plywood
All other WORK	Steel panels, fiberglass, plywood or tongue and groove lumber

1. **Plywood.** Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork, shall conform to the requirements of PS 1 – Construction and Industrial Plywood, for Concrete Forms, Class I, and shall be edge sealed. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.
2. **Steel.** Steel leave-in-place forms shall not be used.
3. **Lumber.** Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20 - American Softwood Lumber Standard. Unless expressly accepted by the ENGINEER, lumber used for forms, shoring, or bracing shall be new material.

2.4 FORM TIES

A. Standard-Application Form Ties.

1. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete.
2. The maximum diameter of removable cones for rod ties or other removable form tie fasteners having a circular cross-section shall not exceed 1.5 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming.
3. Form ties shall be **Wrench Head Snap Tie** by **MeadowBurke**; **Snap-Ties** by **Dayton/Richmond**; or equal.

- B. **Water-Retaining Structures.** Form ties for water-retaining structures shall have integral waterstops that tightly fit the form tie so that they cannot be moved from mid-point of the tie.

PART 3 -- EXECUTION

3.1 GENERAL

- A. **Safety.** In addition to satisfying the design criteria listed above, the CONTRACTOR shall:
1. Provide worker protection from protruding reinforcement bars in accordance with applicable safety codes.
 2. Promptly remove from the WORK any formwork that is unsafe or inadequate in any respect, and replace with formwork that is safe and adequate in all respects.

- B. **Quantity and Availability.** The quantity and availability of forms shall be sufficient to permit the required rate of progress in the WORK.
- C. **Quality Control & Bracing.** The following quality control is required:
 - 1. The inspection of concrete formwork shall comply with applicable local, state, and Federal regulations.
 - 2. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by CONTRACTOR's personnel and by the ENGINEER and shall be in sufficient number and properly installed. During concrete placement, the CONTRACTOR shall continually monitor plumb and string line form positions and immediately correct deficiencies.
- D. **Removal.** All forms shall be removed, after the appropriate curing times have been obtained, unless approved otherwise by the ENGINEER.

3.2 CONSTRUCTION

A. **Vertical Surfaces:**

- 1. Vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated.
- 2. Not less than 1-inch of concrete shall be added to the indicated thickness of a concrete member where concrete is permitted to be placed against trimmed ground in lieu of forms. Permission to do this on other concrete members will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

B. **Construction Joints:**

- 1. Concrete construction joints will not be permitted at locations other than those indicated, except as may be acceptable to the ENGINEER.
- 2. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete.
- 3. Pipe stubs and anchor bolts shall be set in the forms where required.

C. **Form Ties**

- 1. **Embedded Ties:** Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties that cause

spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.

3.3 REMOVAL OF FORMS

- A. Careful procedures for the removal of forms shall be strictly followed, and this WORK shall be done with care so as to avoid injury to the concrete. **No heavy loading on green concrete will be permitted.**
 - 1. **Vertical Walls of Water-Retaining Structures.** For vertical walls of water holding structures, forms shall remain in place at least 36 hours after the concrete has been placed.
 - 2. For parts of the WORK not specifically mentioned herein, forms shall remain in place for periods of time as recommended in ACI 347 - Guide to Formwork for Concrete.

3.4 REUSE OF FORMS

- A. Forms may be reused only if in good condition and only if acceptable to the ENGINEER. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the ENGINEER.

3.5 MAINTENANCE OF FORMS

- A. **General Condition.** Forms shall be maintained in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Before concrete is placed, the forms shall be thoroughly cleaned.
- B. **Form Oil.** The form surfaces shall be treated with a non-staining mineral oil or other lubricant acceptable to the ENGINEER. Any excess lubricant shall be satisfactorily removed before placing the concrete. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

- END OF SECTION -

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SECTION 03 20 00 - REINFORCEMENT STEEL

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide reinforcement steel, accessories, and appurtenant WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals. Submittals shall be provided at the earliest possible date after receipt by the CONTRACTOR of the Notice to Proceed.
- B. **Shop Drawings.** Shop drawings shall be provided for reinforcement steel, showing the details of the reinforcement steel which shall conform to ACI 315 - Details and Detailing of Concrete Reinforcement, and the requirements herein. Shop drawings shall include the following items:
 - 1. **Bending diagrams.** The shop bending diagrams shall show the actual lengths of bars to the nearest inch measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface.
 - 2. **Placement diagrams.** Include bar placement diagrams. These diagrams shall also clearly indicate the dimensions of splices and where they occur.
 - 3. **Bar Quantities.** The quantity of bars shall be identified for each bar configuration.

1.3 QUALITY CONTROL

- A. If requested by the ENGINEER, the CONTRACTOR shall furnish samples from each heat of reinforcement steel in a quantity adequate for testing. Costs of initial tests will be paid by the OWNER. Costs of additional tests if material fails initial tests shall be the CONTRACTOR's responsibility.

PART 2 -- PRODUCTS

2.1 REINFORCEMENT STEEL

- A. **Bar Reinforcement.** Bar and spiral reinforcement shall conform to ASTM A 615 - Deformed and Plain Billet - Steel Bars, for Grade 60 reinforcement unless otherwise indicated.

2.2 ACCESSORIES

- A. Accessories shall include necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement.

- B. **Bar supports.** Bar supports shall meet the requirements of the CRSI Manual of Standard Practice, including special requirements for supporting epoxy-coated reinforcing bars.
1. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating that extends at least 0.5-inch from the concrete surface. Plastic shall be gray in color.
 2. Concrete blocks (i.e. dobies) used to support and position reinforcement steel shall have the same or higher compressive strength as required for the concrete in which they are located. Wire ties shall be embedded in concrete block bar supports.

PART 3 -- EXECUTION

3.1 GENERAL

- A. Reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the Building Code and the supplementary requirements herein.

3.2 FABRICATION

A. **General**

1. Reinforcement steel shall be accurately formed to the dimensions and shapes indicated, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318 - Building Code Requirements for Reinforced Concrete, except as modified by the Drawings. Bars shall be bent cold. Bars shall be bent per ACI 318.
2. The CONTRACTOR shall fabricate reinforcement bars for structures in accordance with bending diagrams, placing lists, and placing drawings.

- B. **Fabricating Tolerances:** Bars used for concrete reinforcement shall satisfy the following fabricating tolerances:

Sheared Length	plus and minus 1-inch
Depth of Truss Bars	plus zero, minus 0.5-inch
Stirrups, ties, and spirals	plus and minus 0.5-inch
Other bends	plus and minus 1-inch

3.3 PLACING

- A. **General.** Reinforcement steel shall be accurately positioned as indicated and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. Tie wires shall be bent away from the forms in order to provide the required concrete coverage. Reinforcement steel shall be supported by

concrete, plastic or metal support spacers, or metal hangers that are strong and rigid enough to prevent any displacement of the reinforcement steel. Concrete dobies used to support reinforcement steel shall be tied to the steel with wire ties that are embedded in the blocks.

B. **Limitations on Bar Supports.** Limitations on the use of bar support materials shall be as follows.

1. Concrete Dobies

a. Permitted at any location except where architectural finish is required.

b. Where concrete is to be placed on the ground, supporting concrete dobies shall be used in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous.

2. Wire Bar Supports: permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.

3. Plastic Bar Supports: permitted at every location except on grade.

C. **Placing Tolerances.** Unless otherwise indicated, reinforcement placing tolerances shall be within the limits in Section 7.5 of ACI 318 except where in conflict with the Building Code.

D. **Adjusting Bar Locations.** Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be as reviewed and accepted by the ENGINEER.

E. **Additional Bars.** Bars additional to those indicated that may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position shall be provided by the CONTRACTOR at its own expense.

3.4 SPACING OF BARS

A. **Clear Distances.**

1. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars, nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one-inch.

2. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall be not less than one-inch.

3. In columns, the clear distance between longitudinal bars shall be not less than 1.5 times the bar diameter, nor less than 1.5 times the maximum size of the coarse aggregate, nor less than 1.5-inches.

4. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

B. **Bar Locations in Walls.** When used to space the reinforcing bars from wall forms, the forms and bars shall be located so that there is no deflection of the accessory when the forms are tightened into position.

3.5 SPLICING

A. **General.** Splices shall only be used at locations indicated. When it is necessary to splice at points other than where indicated, the character of the splice shall be as reviewed and accepted by the ENGINEER. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

B. **Splice Class.** The length of lap for reinforcement bars, unless otherwise indicated, shall be in accordance with ACI 318, Section 12.15.1 for a Class B splice.

C. **Columns.** Splices in column spiral reinforcement, when necessary, shall be made by welding or by a lap of 1.5 turns.

3.6 BENDING OR STRAIGHTENING

A. **Bending or Straightening:** Reinforcement shall not be straightened or rebent in a manner which will injure the material. Bars shall be bent or straight as indicated. Do not use bends different from the bends indicated. Bars shall be bent cold, unless otherwise permitted by the ENGINEER. No bars partially embedded in concrete shall be field-bent except as indicated or specifically permitted by the ENGINEER.

3.7 CLEANING AND PROTECTION

A. Reinforcement steel shall always be protected from conditions conducive to corrosion until concrete is placed around it.

B. The surfaces of reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcement shall be reinspected and, if necessary, recleaned.

3.8 GROUTING OF REINFORCING DOWELS INTO CONCRETE

1. The installation of reinforcement dowels into concrete using an Adhesive System to adhere the reinforcement to the concrete shall be executed per Section 03 65 00 – Adhesive Grout Systems.

- END OF SECTION -

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide cast-in-place concrete in accordance with the Contract Documents.

1.2 DEFINITIONS

- A. HYDRAULIC STRUCTURE. Environmental engineering concrete structures for the containment, treatment, or transmission of water, wastewater, other fluids, or gases.
- B. SPECIAL INSPECTOR. An independent inspector retained for the verification and testing of the WORK.
- C. STRUCTURAL CONCRETE. Structural concrete is all concrete not explicitly defined in the Specifications as non-structural concrete.

1.3 REFERENCES. Unless noted otherwise, the latest version of each References is applicable to the WORK.

- A. ACI 117 – Standard Tolerance for Concrete Construction and Materials.
- B. ACI 214 – Recommended Practice for Evaluation of Strength Test Methods.
- C. ACI 301 – Structural Concrete.
- D. ACI 304.2R – Guide to Placing Concrete by Pumping Methods.
- E. ACI 306.1 – Cold Weather Concreting.
- F. ACI 308 – Standard Practice for Curing Concrete.
- G. ACI 309 – Consolidation of Concrete.
- H. ACI 318 – Building Code Requirements for Structural Concrete.
- I. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures.
- J. ASTM C 31 – Practices for Making and Curing Concrete Test Specimens in the Field.
- K. ASTM C 33 – Concrete Aggregates.
- L. ASTM C 94 – Ready Mixed Concrete.
- M. ASTM C 127 – Test Method for Relative Density and Absorption of Coarse Aggregate.
- N. ASTM C 128 – Test Method for Relative Density and Absorption of Fine Aggregate.
- O. ASTM C 136 – Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- P. ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete.

- Q. ASTM C 150 – Specification for Portland Cement.
- R. ASTM C 156 – Test Method for Water Loss Through Liquid Membrane-Forming Curing Compounds for Concrete.
- S. ASTM C 157 – Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete.
- T. ASTM C 192 – Practice for Making and Curing Concrete Test Specimens in the Laboratory.
- U. ASTM C 231 – Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- V. ASTM C 260 – Air Entraining Admixtures for Concrete.
- W. ASTM C 309 - Liquid Membrane-Forming Compounds for Curing Concrete.
- X. ASTM C 494 – Chemical Admixtures for Concrete.
- Y. ASTM C 566 - Test Method for Total Moisture Content of Aggregate by Drying.
- Z. ASTM C 618 – Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- AA. ASTM C 1064 – Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
- BB. ASTM C 1077 – Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Laboratory Evaluation.
- CC. ASTM C 1260 – Test Method for Potential Alkali Reactivity of Aggregate.
- DD. ASTM C 1293 – Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
- EE. ASTM C 1567 – Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate.
- FF. ASTM D 2419 – Test Methods for Sand Equivalent Value of Soils and Fine Aggregate.

1.4 CONCRETE TYPES

- A. **General.** Concrete used in the WORK shall be provided and tested according to the requirements identified herein.
- B. **Concrete Types.** The CONTRACTOR shall construct concrete elements with the Concrete Type assigned to said elements. The CONTRACTOR is not permitted to construct with an alternative Concrete Type or Subtype without receiving approval by the ENGINEER.
- C. **Standard Structural Concrete.** The following table identifies the Types of standard structural concrete used in the WORK:

Concrete Type	Type of Structural Concrete	Application
Type SR	Standard Regular Mix	Concrete items not indicated otherwise in the Contract Documents.

1.5 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.
- B. **Materials.** Test data relating to the cement, aggregate, and admixtures shall be less than 12 months old. Furnish submittals as required by the Contract Documents and the following in accordance with ACI 301:
 - 1. **Cement.** Mill tests, including fineness, for each shipment of cement to be used.
 - 2. **Aggregates.** Submit gradation test results for aggregate.
 - 3. **Admixtures.** Admixture product data and certifications. Chloride ion content shall be included.
- C. **Concrete Mix Designs:** Prior to the WORK, the CONTRACTOR shall submit concrete mix designs which identify the proportions and gradations of materials proposed for each type of concrete. Costs of laboratory testing related to the submittal of mix designs shall be CONTRACTOR’s responsibility. Regardless of the age of the tests – new trial tests or historical testing – tests shall be performed by an independent testing laboratory acceptable to the ENGINEER. The concrete mix design is subject to rejection by the ENGINEER.
- D. **Field Test Results:** Submit field test results. When tests are conducted as performed by a Special Inspector, the test results shall be certified by the Special Inspector.
- E. **Curing:** Submit materials and methods for curing.
- F. **Temperature-Affected Concrete Work:** If required by the ENGINEER, submit detailed procedures for concrete work in hot or cold weather as required herein.
- G. **Delivery Tickets:** Where ready-mix concrete is used, the CONTRACTOR shall furnish delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state-certified equipment used for measuring and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, the amount of water in the aggregate added at the batching plant, and the amount allowed to be added at the Site for the specific design mix. In addition, each ticket shall state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to the times when the batch was dispatched, when it left the plant, when it arrived at the Site, when unloading began, and when unloading was finished.

1.6 QUALITY CONTROL

- A. **General.** Tests of the component materials and of the concrete shall be performed as indicated. Laboratory and field testing of materials and concrete shall be in accordance

to the standards identified herein. The standards listed in this Paragraph do not contain all standards related to the quality control of the cast-in-place concrete.

- B. **Laboratory Standard.** Laboratories testing concrete material components and mixes shall meet ASTM C 1077.
- C. **Air Content.** Air content of concrete shall be tested in accordance with ASTM C 231. Air content shall be tested at the point of placement.
- D. **Aggregates.**
 - 1. Testing for aggregate shall include sand equivalence, reactivity, abrasion resistance, and soundness, according to ASTM C 33 and this Section of the Specifications.
 - 2. Aggregate testing shall be performed within 12 months of the start of construction and every 12 months during construction to determine continued compliance.
- E. **Slump.** Slump shall be tested in accordance with ASTM C 143.
- F. **Temperature.** Temperature of concrete shall be tested in accordance with ASTM C 1064.
- G. **Curing of Test Specimens.** Field-sampled concrete test specimens shall be handled and cured in accordance with ACI C 31. Laboratory-cured concrete test specimens shall be handled and cured in accordance with ACI C 192.
- H. **Sampling.** Concrete for testing shall be furnished by the CONTRACTOR, and the CONTRACTOR shall assist the ENGINEER in obtaining samples and disposal and cleanup of excess material. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling.
- I. **Special Inspections:** Inspection by a Special Inspector approved by the regulatory body having jurisdiction and by the ENGINEER will be required when necessary to conform with code requirements, or the requirements of the Contract Documents. Inspection reports shall be submitted to the ENGINEER. The Special Inspector shall observe the WORK in conformance to the Contract Documents, including the preparation and taking of test specimens and placement of concrete except sitework concrete which is fully supported on earth.
- J. **Field Testing Costs.**
 - 1. With the exception of items related to Defective WORK, the cost of Special Inspection required by the Code and associated laboratory tests on field-placed concrete will be the OWNER'S responsibility. The CONTRACTOR shall be responsible for the cost of any tests and investigations of WORK that is determined to be Defective WORK.
- K. **Compression Tests**
 - 1. Compression test specimens for concrete shall be made in accordance with Section 9.2 of ASTM C 31. Specimens shall be 6-inches diameter by 12-inches tall cylinders.
 - 2. Each set of specimens shall be a minimum of five (5) cylinders.

3. Sampling of concrete to collect test specimens for each class of concrete shall be as follows.
 - a. Sampling for each class of concrete shall be in accordance with ACI 350, Chapter 5, as follows:
 - 1) Not less than once a day for each class of concrete placed, nor less than:
 - 2) Once for each 100 yd³ of each class of concrete placed each day, nor less than:
 - 3) Once for each 5,000 ft² of slab or wall surface area placed each day.
 - b. Frequency of sampling may be changed at the discretion of the ENGINEER.
4. Compression tests shall be performed in accordance with ASTM C 39. One (1) test cylinder shall be tested at 7 Days and two (2) test cylinders shall be tested at 28 Days. The remaining cylinders will be held to verify test results, if needed.

L. Evaluation and Acceptance of Compressive Strength

1. Evaluation and acceptance of the compressive strength of concrete shall be in accordance to ACI 318, Chapter 5, for non-hydraulic structures; or ACI 350, Chapter 5, for hydraulic structures; and the following:
2. If any concrete fails to meet both of the following requirements, immediate corrective action shall be taken to increase the compressive strength for subsequent batches of the type of concrete affected:
 - a. The arithmetic average of any three (3) strength tests equals or exceeds the required minimum 28-day compressive strength, and;
 - b. No strength test falls below the minimum 28-day compressive strength by more than 500 psi if the 28-day compressive strength is 5,000 psi or less; or more than 10-percent of the 28-day compressive strength is greater than 5,000 psi.
3. When required by the ENGINEER, a statistical analysis of compression test results will be provided by the CONTRACTOR according to ACI 214. The standard deviation of the test results shall not exceed 640 psi, when ordered at equivalent water content as estimated by slump.
4. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any three (3) consecutive tests being below the required compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard deviation.
5. Concrete that fails to meet the ACI requirements and these Specifications is subject to removal and replacement.

M. Mix Design Tolerances:

1. **Measurement of Water.** The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the ENGINEER and capable of measuring the water in variable amounts within a tolerance of one (1) percent. The water feed control mechanism shall be capable of being locked in position so as to deliver constantly any required amount of water to each batch of concrete. A positive quick-acting valve shall be used for a cut-off in the water line to the mixer. The operating mechanism shall prevent leakage when the valves are closed.
2. **Measurement of Cement and Aggregate.** The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the CONTRACTOR and acceptable to the ENGINEER. Weighing tolerances for the materials shall be a maximum of that given below.

Material	Percent of Total Weight
Cement	1
Aggregates	3
Admixtures	3

N. Construction Tolerances:

1. **General.** The CONTRACTOR shall set and maintain concrete forms and perform finishing operations to ensure that the completed WORK is within tolerances. Surface defects and irregularities are defined as finishes and are different from tolerances. Tolerance is the permissible variation from lines, grades, or dimensions indicated on the Drawings.
2. **Permitted Tolerances.** The following non-cumulative construction tolerances apply to finished walls and slabs unless otherwise indicated in the following Table. Where tolerances are not stated in the Specifications, permissible deviations will be in accordance with ACI 117.

Item	Tolerance
Variation of the constructed linear outline from the established position in plan.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation from the level or from the grades indicated.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation from plumb	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation in the thickness of slabs and walls.	Minus 1/4-inch; Plus 1/2-inch
Variation in the locations and sizes of slabs and wall openings	Plus or minus 1/4-inch

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Materials for use in concrete shall comply with ACI 301 and the requirements herein.
- B. Lithium additives shall not be used in concrete mix designs for water bearing structures.
- C. Ready-mix concrete shall conform to the requirements of ASTM C 94.

2.2 CEMENT

- A. **General.** Cement for use in concrete shall comply with ACI 301 and the following requirements:
 - 1. Cement for concrete that will contact potable water shall not be obtained from kilns that burn metal rich hazardous waste fuel.
 - 2. Cement reclaimed from cleaning bags or leaking containers shall not be used.
 - 3. Cement shall be used in the sequence of receipt of shipments.
 - 4. A single brand of cement shall be used throughout the WORK, and prior to its use, the brand shall be accepted by the ENGINEER.
 - 5. Cement that has become lumpy shall not be used.
- B. **Cement Type.** Cement shall be standard brand portland cement conforming to ASTM C 150, for Type I/II.
- C. **Fineness.** A minimum of 85 percent of cement by weight shall pass a 325 screen.
- D. **Test Reports.** Certified mill test reports, including fineness, for each shipment of cement to be used shall be submitted to the ENGINEER, if requested, regarding compliance with the Specifications.

2.3 WATER

- A. **General.** Water for mixing and curing shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies.
- B. **Agricultural water.** Agricultural water with high total dissolved solids (greater than 1000 mg/l TDS) shall not be used.

2.4 AGGREGATE

- A. **General.** Aggregates for use in concrete shall be obtained from pits acceptable to the ENGINEER, shall be non-reactive, and shall conform to ASTM C 33.
- B. **Maximum Size.** Maximum size of coarse aggregate shall be as indicated.

- C. **Lightweight Sand.** Substituting lightweight sand for fine aggregate will not be permitted.
- D. **Coarse Aggregates.** Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock, or a combination thereof. The coarse aggregates shall be prepared and handled in 2 or more size groups for combined aggregates with a maximum size greater than 3/4-inch. When the aggregates are proportioned for each batch of concrete, the 2 size groups shall be combined. When tested in accordance with ASTM C 33, the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions or 10.5 percent after 100 revolutions.
- E. **Fine Aggregates.** Fine aggregates shall be natural sand or a combination of natural and manufactured sand that is hard and durable. When tested in accordance with ASTM D 2419, the sand equivalency shall not be less than 75 percent for an average of 3 samples, nor less than 70 percent for an individual test. Gradation of fine aggregate shall conform to ASTM C 33 when tested in accordance with ASTM C 136 for the fineness modulus of the sand used, including the optional grading in Section 6.2. The fineness modulus of sand used shall not be over 3.1. When tested in accordance with ASTM C 33, the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.
- F. **Combined Aggregates.** Combined aggregates shall be well graded from coarse to fine sizes and shall be uniformly graded between screen sizes to produce concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.
- G. **Ratio of Silica Release.** When tested in accordance with ASTM C 33, the ratio of silica released to reduction in alkalinity shall not exceed 1.0.
- H. **Soundness.** When tested in accordance with ASTM C 33, the loss resulting after 5 cycles of the soundness test shall not exceed 10 percent for fine aggregate and 12 percent for coarse aggregate when using sodium sulfate.
- I. **Reactivity.** Aggregates in the concrete mix shall not react to produce deterioration related to Alkali-Silica Reaction (ASR). The aggregates shall comply with the requirements in the Paragraph "Alkali-Silica Reactivity (ASR) of Aggregates" in this Section.

2.5 FLYASH

- A. Flyash for use in concrete shall be Class F and meet ASTM C 618.

2.6 ADMIXTURES

- A. **General.** Admixtures for use in concrete shall comply with the following requirements:
 - 1. **Single Manufacturer.** Admixtures shall be compatible and be furnished by a single manufacturer capable of providing qualified field service representation.
 - 2. **Application and Use.** Admixtures shall be used in accordance with manufacturer's recommendations. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture.

3. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion, and shall be non-toxic after 30 days.
4. **ENGINEER's Approval.** All admixtures shall be approved by the ENGINEER prior to use.

B. Air-entraining agents.

1. Agents shall meet the requirements of ASTM C 260.
2. The OWNER reserves the right, at any time, to sample and test the air-entraining agent.
3. The air-entraining agent shall be added to the batch in a portion of the mixing water.
4. The solution shall be batched by means of a mechanical batcher capable of accurate measurement.

C. Set controlling and water reducing admixtures:

1. Admixtures shall conform to ASTM C 494. Normal range water reducer shall conform to ASTM C 494, Type A. High range water reducer shall conform to ASTM C 494, Type F or G. All admixtures shall be approved by the ENGINEER prior to use.
2. Admixtures may be added at the CONTRACTOR's option, subject to the ENGINEER's approval, to control the set, effect water reduction, and increase workability. The cost of adding an admixture shall be the CONTRACTOR's responsibility.
3. The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.
4. Concrete shall not contain more than one water reducing admixture.
5. Concrete containing a set-controlling or water reducing admixture shall be first placed at a location determined by the ENGINEER.
6. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used.
7. **Set controlling admixtures.** Set controlling admixture may be either with or without water-reducing properties. Admixture shall be appropriate for the air temperature at time of placement.
8. **High range water reducing admixtures (HRWR Admixtures).** High range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified. All admixtures shall be approved by the ENGINEER prior to use.
 - a. Water reducer shall be considered as part of the mixing water when calculating the water/cement ratio.
 - b. If the high range water reducer is added to the concrete at the Site, it may be used in conjunction with the same water reducer added at the batch

plant. Concrete shall have a slump of 3-inches plus or minus 1/2-inch prior to adding the high range water reducing admixture at the Site.

- c. The high range water reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the primary system.
- d. Concrete shall be mixed at mixing speed for a minimum of 70 mixer revolutions or 5 minutes after the addition of the high range water reducer, unless recommended otherwise by the manufacturer.

2.7 ALKALI-SILICA REACTIVITY (ASR) OF AGGREGATES.

- A. **General.** All aggregates used in the concrete mix designs shall generally be considered non-reactive (innocuous) aggregate according to the requirements of ASTM C 1260 or ASTM C 1567 and tested according to the requirements below.
- B. **Standard Aggregate Test.** Fine and coarse aggregates to be used in all concrete shall be evaluated individually and tested for alkali-aggregate reactivity, according to ASTM C 1260. The average expansion of the mortar bars for the fine aggregate test according to ASTM C 1260 shall not exceed 0.10% at 16-days of immersion in a 1N NaOH solution. Likewise, the average expansion of the mortar bars for the coarse aggregate test according to ASTM C 1260 shall not exceed 0.10% at 16-days of immersion in a 1N NaOH solution.
- C. **Subsequent Approach.** If either of the aggregates do not pass the ASTM C 1260 test requirements as described above, the CONTRACTOR shall provide the following:
 1. Information to the ENGINEER that the proposed fine and course aggregate is the best (i.e. least reactive) locally available material within 100-miles of the Project site.
 2. In addition, the CONTRACTOR shall provide testing of the proposed aggregates (fine and course) along with approved mitigating additives (i.e. fly ash, class N pozzolan, GGBF slag, silica fume or other approved additives) to the concrete mix design, according to the requirements of ASTM C 1567 and the following requirements:
 - a. The concrete mix design parameters used in the ASTM C 1567 expansion test shall be within the allowable ranges of mix design parameters as specified under the Paragraph "Alkali-Silica Reactivity (ASR) of Aggregates" of this Section. After 16-days of immersion in a 1N NaOH solution, the average expansion of the three mortar bars shall not exceed 0.10% as measured according to ASTM C 1567 standards and protocol.
 - b. ASR tests on both the fine and course aggregate and concrete mix additives (i.e. flyash, pozzolan, or other approved additives), sample bar preparation, testing and all analytical methods shall meet the ASTM C 1567 testing procedural requirements.
 - c. Alkali content of the cement in the proposed concrete mix design shall not be greater than the alkali content of the cement used in the test samples.

- d. Results of the ASR test show that expansion of the concrete sample is less than 0.10% at 16-days after the start of the expansion test procedure.
 - e. Test results shall be reported to the CONTRACTOR and Design Engineer at 7-days, 11-days, and 16-days.
 - f. The Concrete Supplier is still actively mining and using aggregate from the same representative portion of the aggregate pit from which the aggregate samples were taken for testing.
- D. **Alternative Subsequent Approach.** In lieu of the ASR testing above the aggregate may be tested in accordance with the requirements of ASTM C 1293, meeting the following requirements:
- 1. The concrete mix design parameters used in the ASTM C 1293 expansion test shall be within the allowable ranges of mix design parameters as specified under Paragraph “Alkali-Silica Reactivity (ASR) of Aggregates” of this Section.
 - 2. Alkali content of the cement in the proposed concrete mix design shall not be greater than the alkali content of the cement used in the test samples.
 - 3. Results of the test, in accordance with ASTM C 33, shall indicate less than 0.04% expansion at 1-year for cement aggregate combinations to demonstrate aggregates to be non-reactive.
 - 4. Results of the test, in accordance with ASTM C 33, shall indicate less than 0.04% expansion at 2-years for cement aggregate combinations with pozzolan or slag to demonstrate aggregates to be non-reactive.

2.8 CURING MATERIALS

- A. **Curing Compounds.** Curing compounds shall be resin-based, compliant with local VOC requirements, and meet the following requirements:
- 1. Concrete curing compound shall be approved by the ENGINEER prior to use.
 - 2. Regular curing compounds shall be white pigmented and conform to ASTM C 309, Type 2, Class B. Sodium silicate compounds shall not be allowed.
 - 3. When curing compound must be removed for finishes or grouting, compounds shall be a dissipating type meeting ASTM C 309, type 1 or 2, Class B.
- B. **Polyethylene sheets.** Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6-mils. The loss of moisture when determined in accordance with ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.
- C. **Polyethylene-coated waterproof paper sheeting.** Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, have a nominal thickness of 2-mils, and be permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A – Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant). The loss of moisture, when

determined in accordance with ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.

- D. **Polyethylene-coated burlap.** Polyethylene-coated burlap for use as concrete curing blanket shall be 4-mils thick with white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.
- E. **Curing Mats.** Curing mats for use in Curing Method 6 below shall be heavy shag rugs or carpets or cotton mats quilted at 4-inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.
- F. **Evaporation retardant.** Evaporation retardant shall be a material such as **Confilm** by **BASF**, **Eucobar** by **Euclid Chemical Company**, **E-CON** by **L & M Construction Chemicals, Inc.**, or equal.

2.9 MISCELLANEOUS MATERIALS

- A. **General.** All miscellaneous materials shall be approved by the ENGINEER prior to use.
- B. **Bonding Agents.** Bonding agents shall be epoxy adhesives conforming to the following:
 - 1. For bonding freshly-mixed, plastic concrete to hardened concrete, **Sikadur 32 Hi-Mod Epoxy Adhesive** by **Sika Corporation**, **Concresive Liquid (LPL)** by **BASF**, **BurkEpoxy MV** by **Burke** by **Edoco**, or equal.
- C. **Joint Materials.** Joints materials shall conform to Section 03 32 00 – Joints in Concrete.

2.10 CONCRETE MIX DESIGN REQUIREMENTS

- A. **General:** Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage, and where deposited in forms, to have good consolidation properties and maximum smoothness of surface. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items.
- B. **Proportions:** Exact proportions of individual mix components each concrete mix will be determined in advance of the placement of that mix, and these proportions shall be submitted to the ENGINEER for review.
- C. **Adjustments to the Mix Design:** The CONTRACTOR shall adjust the design mixes whenever such change is necessary to secure the required strength, density, workability, and surface finish. In addition, the CONTRACTOR may elect to decrease the water/cement ratio to enhance the strength and shrinkage performance and/or add water reducers, as required to achieve workability. Whether changes are performed to achieve the requirements of the Specifications or performed to enhance workability, the CONTRACTOR shall be entitled to no additional compensation because of such changes. Any changes to the accepted concrete mix design shall be submitted to the ENGINEER for review and is subject to testing in accordance with these Specifications.

- D. **Water/Cement Ratio W/C:** The water/cement ratio indicated is for saturated-surface dry condition of aggregate. Every Day, throughout the day, the water added to batches shall be adjusted as required to account for changes in the total free moisture in the aggregates. The total free moisture in the aggregates shall be determined as follows:
1. Total free moisture of aggregates shall be determined by subtracting both the moisture absorbed by the fine aggregate (determined per ASTM C 128) and the moisture absorbed by the coarse aggregate (determined per ASTM C 127) from the total moisture content of all aggregate (determined by ASTM C 566).
- E. **Aggregate Composition:** In mix designs for structural concrete, the percentage of fine aggregate in total aggregate by weight shall be as indicated in the following table.

FINE AGGREGATE	
Fineness Modulus	Maximum Percent of Fine Aggregate in Total Aggregate, by Weight
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.1	44
Over 3.1	The Fine Aggregate is Not Permitted for use.

1. For non-structural concrete, the maximum percentage of fine aggregate of total aggregate by weight shall not exceed 50.
- F. **Water Reducing Admixtures:** No more than 14 ounces of water reducer per sack of cement shall be used.
- G. **Trial Batches:** If the preparation and testing of a trial batch is required to verify the performance and quality of a concrete mix, then the CONTRACTOR shall prepare and test a trial batch in conformance with the requirements herein.
- H. **Concrete Property Tables**
1. **General.** Concrete mixes shall meet the criteria identified in the Concrete Property Tables below.
 2. **Disclaimer.** The CONTRACTOR is cautioned that the limiting parameters are not a mix design. Admixtures may be required to achieve workability required by the CONTRACTOR's construction methods and aggregates. The CONTRACTOR is responsible for providing concrete with the required workability and strength.
 3. **Higher Quality Mixes.** The CONTRACTOR is permitted to propose substitutions for any given type or subtype of concrete to the ENGINEER for approval, and this may include substitutions that will reduce the total number of mix types used in the WORK. Notwithstanding any provision in the Specifications, only mix designs approved by the ENGINEER can be used in the WORK.

Concrete Properties Table – Standard Structural Concrete

Mix Type:	SR (Exterior Use)	<i>Table Column Not Used</i>	<i>Table Column Not Used</i>	<i>Table Column Not Used</i>
Min 28 Day Compressive Strength, psi (f'c)	4,500			
Max 28 Day Compressive Strength, psi	N/A			
Max Aggregate Size, in	1			
Max Allowable Fly Ash Content, lbs/cubic yard	Up to 120 (i.e up to 15% max of cement content)			
Max Water/Cement Ratio, by weight	0.42			
Total Air Content, percentage volume	4.5 to 7.5			
Slump, in	<u>Without HRWR:</u> 3-in +/- 1-in <u>With HRWR:</u> 7-in +/- 2-in			
Trial Batch Required (Y/N)	No			

Concrete Properties Table – Other Concrete			
Mix Type:	Sitework	Lean	<i>Table Column Not Used</i>
Min 28 Day Compressive Strength, psi (f'c)	3,000	2,000	
Max 28 Day Compressive Strength, psi	N/A	N/A	
Max Aggregate Size, in	1	1	
Max Allowable Fly Ash Content, lbs/cubic yard	Fly Ash content shall be submitted to ENGINEER for approval prior to use.	Fly Ash content shall be submitted to ENGINEER for approval prior to use.	
Max Water/Cement Ratio, by weight	0.45	0.60	
Total Air Content, percentage volume	4 to 7	4.5 to 7.5	
Slump, in	<u>Ductbanks & Encasements:</u> 5-in +/- 1-in <u>Other Uses:</u> 3-in +/- 1-in	3-in +/- 1-in	
Trial Batch Required (Yes/No)	No	No	

2.11 CONSISTENCY

- A. **General.** The quantity of water in a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete that can be worked properly into place without segregation and which can be compacted by vibratory methods to give the desired density, impermeability, and smoothness of surface.
- B. **Uniformity.** The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of a desired consistency.

- C. **Testing.** The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143. The slumps shall be as indicated with the concrete properties.

2.12 TRIAL BATCH AND LABORATORY TESTS

- A. *Since laboratory trial batches require 35 calendar days to complete, the CONTRACTOR shall test a minimum of 2 mix designs for each class of concrete.*

- B. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch testing requirements or approved historical concrete testing results as specified below.

- 1. **Trial Batch Concrete Testing.** Before placing any concrete, a testing laboratory selected by the ENGINEER shall prepare a trial batch of each class of structural concrete, based on the preliminary concrete mixes submitted by the CONTRACTOR. During the trial batch the aggregate proportions may be adjusted by the testing laboratory using the two coarse aggregate size ranges to obtain the required properties. If one size range produces an acceptable mix, a second size range need not be used. Such adjustments will be considered refinements to the mix design and will not be the basis for extra compensation to the CONTRACTOR. Concrete shall conform to the requirements of this Section whether the aggregate proportions are from the CONTRACTOR's preliminary mix design or whether the proportions have been adjusted during the trial batch process. The trial batch shall be prepared using the aggregates, cement, and admixture proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 6 compression test specimens from each batch.

- 2. **Historical Concrete Testing.** For ASR expansion testing requirements, the CONTRACTOR may propose the use of historical test results on these tests provided that all of the following conditions are met:

- 1. The test results are no more than 12-months old from the project Notice-to-Proceed date.

- 2. The mix design used in the proposed historical tests has the same characteristics, as described below, as the mix design proposed for use on the project:

- a. The type and quantity of cement used in the historical tested mix, is the same as that of the proposed mix design.
- b. The quantity and source location of the coarse and fine aggregate used in the historical tested mix is the same as that of the proposed mix design. In addition, the aggregate used in the historical tests must be screened to the same gradations as that proposed for the project mix design.
- c. The type and quantity of cementations substitutes (fly ash or slag or other approved substitute) used in the historical tested mix, is the same as that of the proposed mix design.
- d. The water to cement ratio of the historical tested mix is within +/- 5% of the proposed water to cement ratio.

- e. The air content of the historical tested mix is within 1% of the proposed air content (for example: for a proposed air content of 6% in the proposed mix design, the historical air content must be in the range of 5 to 7%.)
 - f. The same additives, including water reducing additives, that were used in the historical batch test results are being proposed for the new concrete mix design, and the proportions of those additives used in the historical mix design are within +/- 5% of that of the proposed project mix design.
- C. **Compressive Strength Testing.** The determination of compressive strength will be made by testing 6-inch diameter by 12-inch high cylinders; made, cured, and tested in accordance with ASTM C 192 and ASTM C 39. Three compression test cylinders will be tested at 7 Days and 3 at 28 Days. The average compressive strength for the 3 cylinders tested at 28 Days for any given trial batch shall not be less than 125 percent of the indicated compressive strength.
- D. **Sieve Analyses.** A sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements of ASTM C 136. Values shall be given for percent passing each sieve.

2.13 READY-MIXED CONCRETE

- A. At the CONTRACTOR'S option, ready-mixed concrete may be used if it meets the requirements as to materials, batching, mixing, transporting, and placing indicated herein and is in accordance with ASTM C 94, including the following supplementary requirements.
- B. Ready-mixed concrete shall be delivered to the WORK, and discharge shall be completed within one hour after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever occurs first.
- C. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be the resettable, recording type and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.
- D. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. Materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.
- E. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one-inch when the required slump is 3-inches or less, or if they differ by more than 2-inches when the required slump is more than 3-inches, the mixer shall not be used on the WORK unless the causative condition is corrected and satisfactory performance is verified by additional slump tests. Mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

- F. Each batch of ready-mixed concrete delivered to the Site shall be accompanied by a delivery ticket that is furnished to the ENGINEER in accordance with the Paragraph "Delivery Tickets" of this Section.
- G. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the ENGINEER.

PART 3 -- EXECUTION

3.1 PROPORTIONING AND MIXING

- A. **Proportioning:** Proportioning of the mix shall conform to ACI 301.
- B. **Mixing:** Mixing shall conform to ACI 301.
- C. **Slump:** Slumps shall be as indicated.
- D. **Cement:** The cement shall be suitably protected from exposure to moisture until used.
- E. **Retempering:** Retempering of concrete that has partially hardened shall not be permitted.

3.2 PREPARATION OF EARTH SURFACES FOR CONCRETING

- A. **General:** Earth surfaces to receive concrete directly shall be thoroughly wetted by sprinkling prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.
- B. **Joints in Concrete:** Construction joints are defined as concrete surfaces upon which or against which concrete is to be placed but placement of concrete has been stopped or interrupted and the ENGINEER has determined that the new concrete cannot be incorporated integrally with the concrete previously placed. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of laitance, loose or defective concrete, foreign material, and be roughened to a minimum 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing. Pools of water shall be removed from the surface of construction joints before the new concrete is placed.
- C. **Placing Interruptions:** When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means that will secure proper union with subsequent WORK; provided that construction joints shall be made only where acceptable to the ENGINEER.
- D. **Acceptable by Engineer:** No concrete shall be placed until formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the ENGINEER at least 4 hours before placement of concrete.

- E. **Reinforcement and other Fully or Partially Embedded Items:** Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations indicated on the Drawings or shown by Shop Drawings and shall be acceptable to the ENGINEER before any concrete is placed. Accuracy of placement is the responsibility of the CONTRACTOR.
- F. **Casting New Concrete Against Old:** Where concrete is to be cast against old concrete (defined as any concrete which is greater than 60 Days old), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting or sandblasting to expose aggregate. The joint surface shall be coated with an epoxy bonding agent unless determined otherwise by the ENGINEER. This provision shall not apply to joints where waterstop is provided.
- G. **Dewatering:** No concrete shall be placed in any structure until water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes or other means, and carried out of the forms, clear of the WORK. Unless explicitly accepted by the ENGINEER as underwater concrete work, no concrete shall be deposited underwater nor shall the CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set. Pumping or other necessary dewatering operations for removing ground water, if required, shall be subject to review by the ENGINEER.
- H. **Flowing Water:** Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete.
- I. **Corrosion Protection:** Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2-inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.
- J. **Templates for Anchor Bolts:** Anchor bolts shall be accurately set and shall be maintained in position by templates while embedded in concrete.
- K. **Cleaning Prior to Placement:** The surfaces of metalwork to be in contact with concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed. Surfaces of forms and embedded items that have become encrusted with dried grout from previous usage shall be cleaned before the surrounding or adjacent concrete is placed.

3.3 HANDLING, TRANSPORTING, AND PLACING

- A. **General:** Placing of concrete shall conform to the applicable portions of ACI 301 and the requirements of this Section. No aluminum materials shall be used in conveying any concrete.
- B. **Aluminum:** Aluminum conduits for conveying the concrete shall not be permitted.
- C. **Non-Conforming WORK or Materials:** Concrete which during or before placing is found not to conform to the requirements indicated herein or which is of inferior quality shall be subject to rejection by the ENGINEER.
- D. **Unauthorized Placement:** No concrete shall be placed except in the presence of a duly authorized representative of the ENGINEER.

- E. **Notice of Placement:** The CONTRACTOR shall notify the ENGINEER in writing at least 24 hours in advance of placement of any concrete.
- F. **Placement in Forms:** Concrete shall not be dropped through reinforcement steel or into any deep form, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, means such as hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation. As the WORK progresses, the concrete shall be vibrated and carefully worked around the reinforcement. In addition to the above, the work shall conform to the following requirements:
1. **Walls:** In no case shall the free fall of concrete below the ends of ducts, chutes, or buggies exceed 4-feet in walls. Concrete in wall forms shall be deposited in uniform horizontal layers not deeper than 2-feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in wall forms shall not exceed 5-feet of vertical rise per hour.
 2. **Sloped Slabs:** Concrete placement in sloping slabs shall proceed uniformly from the bottom of the slab to the top for the full width of the placement. The surface of the slab shall be screeded in an up-slope direction.
 3. **Uniformity:** Concrete shall be uniformly distributed within the form receiving concrete during the process of depositing.
 4. **Horizontal Displacement:** In no case after depositing shall any portion be displaced in the forms more than 6-feet in horizontal direction.
 5. **Visibility of WORK:** Sufficient illumination shall be provided in the interior of forms so that the concrete at the places of deposit is visible from the Inspector's access.
 6. **Levelness:** The surface of the concrete shall be level whenever a run of concrete is stopped. For a level, straight joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2-inch above the underside of the strip. About one hour after the concrete is placed, the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel and laitance shall be removed.
- G. **Conveyor Belts and Chutes:** Ends of chutes, hopper gates, and other points of concrete discharge throughout the CONTRACTOR's conveying, hoisting, and placing system shall be designed and arranged so that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of a type acceptable to the ENGINEER. Chutes longer than 50-feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the indicated consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. Conveyor belts and chutes shall be covered.
- H. **Temperature of Concrete:** The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 50 degrees F. For sections less than 12-inches thick the temperature of concrete when placed shall be not less than 55 degrees.

1. If required by ENGINEER, CONTRACTOR shall submit detailed procedures for production, transportation, placement, protection, curing, and temperature monitoring of concrete during hot or cold weather. The submittal shall include procedures to be implemented upon abrupt changes in weather conditions or equipment failures.
2. CONTRACTOR shall not be entitled to additional compensation for satisfying the hot weather placement or the cold weather placement requirements below.

I. Hot Weather Concrete Work

1. **Cement:** If the temperature of the concrete is 85 degrees F or greater, the time between introducing the cement into the aggregates and discharge shall not exceed 45 minutes.
2. **Cooling:** If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, CONTRACTOR shall employ effective means such as precooling of aggregates and using ice as mixing water or placing at night as necessary to maintain the temperature of the concrete below 90 degrees F as it is placed.
3. **Curing:** During the curing period, the maximum temperature decrease measured at the surface of the concrete shall not exceed 50 degrees F in 24 hours nor 5 degrees F in one hour.

J. Cold Weather Concrete Work

1. **General:** Placement of concrete shall conform to ACI 306.1.
2. **Preparation:** Remove snow, ice, and frost from the surfaces, including reinforcement, against which concrete is to be placed. Before beginning concrete placement, thaw the subgrade to a minimum depth of 6-inches. Reinforcement and embedded items shall be warmed to above 32 degrees F prior to concrete placement.
3. **Minimal Heat:** Concrete ingredients shall not be heated more than necessary to prevent the temperature of the mixed concrete, as placed, from falling below the minimum temperature criterion.
4. **Temperature after Placement:** Maintain the concrete temperature above 50 degrees F for at least 72 hours after placement.
5. **Curing:** Curing in cold weather shall conform with the following criteria:
 - a. Water curing of concrete may be reduced to 6 Days during periods when the mean daily temperature in the vicinity of the Site is less than 40 degrees F; provided that during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing is temporarily discontinued.
 - b. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise the concrete shall be protected against freezing temperatures for 72 hours immediately following 72

hours protection at 50 degrees F. Concrete cured by water shall be protected against freezing temperatures for 72 hours immediately following the 72 hours of protection at 50 degrees F.

- c. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F in 24 hours. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 successive Days, the required 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 degrees F; provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.
- d. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted.

3.4 PUMPING OF CONCRETE

- A. **General:** If the pumped concrete does not produce satisfactory end results, the CONTRACTOR shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.
- B. **Pumping Equipment:** Pumping equipment shall conform to the following requirements:
 - 1. The pumping equipment shall have 2 cylinders and be designed to operate with one cylinder in case the other one is not functioning. In lieu of this requirement, the CONTRACTOR may have a standby pump on the Site during pumping.
 - 2. The minimum diameter of the hose conduits shall be in accordance with ACI 304.2R.
 - 3. Pumping equipment and hose conduits that are not functioning properly shall be replaced.
- C. **Field Control:** Concrete samples for slump, air content, and test cylinders will be taken at the placement end of the hose.

3.5 ORDER OF PLACING CONCRETE

- A. **General - Construction Joints:** The order of placing concrete in the WORK shall be acceptable to the ENGINEER. To minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints at the indicated locations.
- B. **Adjacent Placements:**
 - 1. **General:** The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 5 Days for hydraulic structures and 2 Days for all other structures before the contiguous unit or units are placed.

2. **Corner Sections of Walls:** Notwithstanding any direction herein, the corner sections of walls shall not be placed until the 2 adjacent wall panels have cured at least 10 Days for hydraulic structures and 4 Days for all other structures.

3.6 TAMPING AND VIBRATING

- A. **General.** As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted throughout the entire depth of the layer which is being consolidated into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete.
- B. **Vibrators.** Vibrators shall be Group 3 per ACI 309 – Consolidation of Concrete, high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit as required. Group 2 vibrators may be used only at specific locations when accepted by the ENGINEER. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the required results within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall not contact the surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.
- C. **Waterstops.** Care shall be used in placing concrete around waterstops. The concrete shall be carefully worked by rodding and vibrating to make sure that air and rock pockets have been eliminated. Where flat-strip type waterstops are placed horizontally, the concrete shall be worked under the waterstops by hand, making sure that air and rock pockets have been eliminated. Concrete surrounding the waterstops shall be given additional vibration over and above that used for adjacent concrete placement to assure complete embedment of the waterstops in the concrete.
- D. **Walls.** Concrete in walls shall be internally vibrated, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against each surface. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly.

3.7 FINISHING CONCRETE SURFACES

- A. **General:** Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface.
- B. **Tolerances:** Allowable deviations from plumb or level and from the alignment, profiles, and dimensions indicated are defined as tolerances and are indicated above. These tolerances are to be distinguished from irregularities in finish as described herein.
- C. **Aluminum:** Aluminum finishing tools shall not be used.
- D. **Formed Surfaces:**
 1. **General:** Excluding architectural finishes which shall be provided as indicated where required, no treatment is required after form removal except for curing, repair of defective concrete, and treatment of surface defects.
 2. **Exposed Walls:** Formed surfaces of basins and exposed walls shall conform to the following:

- a. Surface holes larger than 1/2-inch in diameter or deeper than 1/4-inch are defined as surface defects in exposed walls.

E. Unformed Surfaces:

F. **1. General:** The following requirements apply to concrete surfaces that require treatment after proper placement, including adequate vibration and tamping, and form removal as necessary for the application of the treatment.

G. **2. Top surfaces.** Unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each operation as necessary to prevent drying shrinkage cracks. The classes of finish for unformed concrete surfaces are defined as follows:

1. Finish Schedule.

1. Finish U1 - Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8-inch. No further special finish is required.
2. Finish U2 - After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where indicated or as determined by the ENGINEER.
3. Finish U3 - After the Finish U2 surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of irregularities.
4. Finish U4 - Trowel the Finish U3 surface to remove local depressions or high points. In addition, the surface shall be given a light broom finish with brooming perpendicular to drainage unless otherwise indicated. The resulting surface shall be rough enough to provide a nonskid finish.
5. Unformed surfaces shall be finished according to the following schedule:

UNFORMED SURFACE FINISH SCHEDULE	
Area	Finish
Grade slabs and foundations to be covered with concrete or fill material	U1
Water bearing slabs with slopes 10 percent and less	U3
Water bearing slabs with slopes greater than 10	U4

percent	
Slabs not water bearing	U4
Top surface of walls	U3

3.8 CURING

- A. **General:** Concrete shall be cured for not less than 7 Days after placing, in accordance with the methods indicated below for the different parts of the WORK. Curing in hot and cold weather shall conform with additional criteria as defined in this Section.

Surface to be Cured	Method
Unstripped forms	1
Wall sections with forms removed	6
Construction joints between footings and walls	2
Encasement and ductbank concrete and thrust blocks	3
Concrete surfaces not specifically indicated in this Paragraph	4
Floor slabs on grade in hydraulic structures	5

- B. **Method 1:** Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removal. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 7 Days of placing the concrete, curing shall be continued in accordance with Method 6 below.
- C. **Method 2:** The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.
- D. **Method 3:** The surface shall be covered with moist earth not less than 4 hours nor more than 24 hours after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 Days after placement of concrete.
- E. **Method 4:** The surface shall be sprayed with a liquid curing compound.
1. Compound shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film that will seal thoroughly.
 2. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7 Day curing period. If the seal is damaged or broken before expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

3. Wherever curing compound has been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.
4. Curing compound shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces and within 2 hours after removal of forms. Repairs to formed surfaces shall be made within the 2 hour period; provided, however, that any such repairs which cannot be made within the said 2 hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound.
5. At locations where concrete is placed adjacent to a panel which has been coated with curing compound, the panel shall have curing compound reapplied to an area within 6-feet of the joint and to any other location where the curing membrane has been disturbed.
6. Prior to final acceptance of the WORK, visible traces of curing compound shall be removed in such a manner that does not damage the surface finish.

F. Method 5:

1. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed. The concrete shall be given a coat of curing compound in accordance with Method 4 above. Not less than one hour nor more than 4 hours after the curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall be polyethylene sheet, polyethylene-coated waterproof paper sheeting, or polyethylene-coated burlap. The blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3-inches and fastened together with a waterproof cement to form a continuous watertight joint.
2. The curing blankets shall be left in place during the 7 Day curing period and shall not be removed until after concrete for adjacent WORK has been placed. If the curing blankets become torn or otherwise ineffective, the CONTRACTOR shall replace damaged sections. During the first 3 Days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket. The CONTRACTOR shall add water under the curing blanket as often as necessary to maintain concrete surfaces damp.

G. Method 6: This method applies to both walls and slabs.

1. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 Days beginning immediately after the concrete has reached final set or forms have been removed.
2. Until the concrete surface is covered with the curing medium, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed.

3. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held substantially in contact with the concrete surface to prevent dislodging by wind or any other causes. Edges shall be continuously held in place.
4. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.
5. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall be removed, the entire concrete surface shall be wetted, and curing compound shall be immediately applied to the entire surface in accordance with Method 4 above.
6. The CONTRACTOR shall dispose of excess water from the curing operation to avoid damage to the WORK.

3.9 REATMENT OF SURFACE DEFECTS

- A. As soon as forms are removed, exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the ENGINEER. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as indicated below. Concrete containing extensive voids, holes, honeycombing, or similar depression defects shall be completely removed and replaced. Repairs and replacements shall be performed promptly.
- B. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of laitance and soft material, plus not less than 1/32-inch depth of the surface film from hard portions by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces underneath will remain moist but not so wet as to overcome the suction upon which a good bond depends. The material used for repair shall consist of a mixture of one sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of **Atlas white** portland cement as is required to make the color of the patch match the color of the surrounding concrete.
- C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. Holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross section and other imperfections having a depth greater than their least surface dimension shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.
- D. Repairs shall be built up and shaped in such a manner that the completed WORK will conform to the requirements of this Section, as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

- E. Prior to filling any structure with water, cracks shall be "vee'd" as indicated and filled with sealant conforming to the requirements of Section 03 32 00 – Joints in Concrete. This repair method shall be done on the water bearing face of members. Prior to backfilling, faces of members in contact with fill which are not covered with a waterproofing membrane shall also have cracks repaired as indicated herein.

3.10 PATCHING HOLES IN CONCRETE

A. Patching Small Holes

1. Holes that are less than 12-inches in the least dimension and extend completely through concrete members shall be filled.
2. Small holes in members that are water-bearing or in contact with soil or other fill material shall be filled with non-shrink grout. Where a face of the member is exposed to view, the non-shrink grout shall be held back 2-inches from the finished surface. The remaining 2-inches shall then be patched according to the Article above entitled "Treatment of Surface Defects."
3. Small holes through other concrete members shall be filled with non-shrink grout, with exposed faces treated as above.

B. Patching Large Holes

1. Holes which are larger than 12-inches in the least dimension shall have a keyway chipped into the edge around the opening, unless a formed keyway exists. The holes shall then be filled with concrete as indicated herein.
2. Holes which are larger than 24-inches in the least dimension and which do not have reinforcing steel extending from the existing concrete, shall have reinforcing steel set in grout in drilled holes. The reinforcing added shall match the reinforcing in the existing wall unless indicated otherwise.
3. Large holes in members that are water bearing or in contact with soil or other fill shall have a hydrophilic type waterstop material placed around the perimeter of the hole unless there is an existing waterstop in place. The hydrophilic waterstop material and execution shall be in conformance with Section 03 32 00 – Joints in Concrete.

3.11 JOINTS

1. Execution of joints shall conform with Section 03 29 00 – Joints in Concrete.

3.12 PROTECTION OF CONCRETE

- A. The CONTRACTOR shall protect concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance.
- B. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface.
- C. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever precipitation is imminent or occurring.

3.13 REJECTED CONCRETE

- A. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed WORK, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete.

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SECTION 03 32 00 - JOINTS IN CONCRETE

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide joints in concrete, complete and in place, in accordance with the Contract Documents.
- B. Joints in concrete structures shall be the types defined below and will be permitted only where indicated, unless specifically accepted by the ENGINEER.

1.2 TYPES OF JOINTS

A. Construction Joints

- 1. The purpose of a construction joint is to bond concrete from an earlier pour to that of a later pour, and if in a water-bearing member, prevent water seepage at the joint location.
- 2. When fresh concrete is placed against a hardened concrete surface, the joint between the pours shall be defined as a construction joint.
- 3. Reinforcement typical to the slab exists across the joint.
- 4. Unless otherwise indicated, joints in water-bearing members shall be provided with a waterstop and/or joint sealant groove of the shape indicated.

B. Expansion Joints

- 1. The purpose of an expansion joint is to allow concrete to expand freely as required, and if in a water-bearing member, prevent water seepage at the joint location.
- 2. In order to allow the concrete to expand freely, a space shall be provided between the pours. The space shall be obtained by placing a joint filler (pre molded expansion joint material) against the earlier pour to act as a form for the later pour.
- 3. Reinforcement typical to the slab does not pass through the joint. Sleeve-like dowels may exist across the joint, as indicated.
- 4. Unless otherwise indicated, joints in water-bearing members shall be provided with a waterstop of the shape indicated.

C. Crack Control Joints

- 1. The function of the control joint is to provide a weaker plane in the concrete where shrinkage cracks would likely occur, and if in a water-bearing member, prevent water seepage at the joint location. There are different

alternatives that can achieve this goal. The alternative(s) selected for the WORK is (are) provided in the Contract Documents.

2. Reinforcement typical to the slab exists across the joint.
3. Unless otherwise indicated, joints in water-bearing members shall be provided with a waterstop and/or joint sealant groove of the shape indicated.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. **Shop Drawings**

1. Furnish placement drawings showing the location and types of joints for each structure.

C. **Manufacturer's Information and Certificates**

1. Furnish manufacturer's information demonstrating compliance of the following with the indicated requirements:

a. **Waterstops.** Prior to use of the waterstop material in the field, a sample of a prefabricated (shop made fitting) mitered cross and a tee constructed of each size or shape of material to be used shall be submitted. Samples shall be prefabricated (shop made fitting) so that the material and workmanship represent the fittings to be provided.

b. preformed joint filler

c. backing rod

d. bearing pad

e. slip dowels

2. Furnish written certification from the manufacturer, as an integral part of the shipping form, that the material shipped to the Site meets or exceeds the indicated physical property requirements.

3. Supplier certificates will not be accepted.

D. **Samples**

1. Prior to production of the material required under this Section, submit qualification samples of waterstops which accurately represent the material being provided.

2. Such samples shall be extruded or molded sections of each size or shape to be installed.

3. The balance of the material to be used shall not be produced until after the ENGINEER has reviewed the qualification samples.

E. Welding Certification

1. Furnish copies of the waterstop welding certification by manufacturer or authorized agent of the manufacturer.
2. Every person who is to be involved with waterstop installation shall be required to have individual certification on file with the ENGINEER, stating that the named individual is certified and trained to install waterstop in accordance with the manufacturer's recommendations and specifications.

1.4 QUALITY CONTROL

A. Waterstops

1. Inspections.

- a. Waterstop field joints shall be subject to inspection, and no such WORK shall be scheduled or started without having made prior arrangements with the ENGINEER for the required inspections.
- b. Provide not less than 24 hours notice for the scheduling of such inspections.
- c. Field joints in waterstops shall be subject to inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects that would reduce the potential resistance of the material to water pressure at any point.

2. Defects. The following waterstop defects represent a partial list of defects which shall be grounds for rejection:

- a. Offsets at joints greater than 1/16 inch or 15 percent of material thickness at any point, whichever is less.
- b. Exterior cracking at the joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness at any point, whichever is less.
- c. Any combination of offset or exterior cracking that will result in a net reduction in the cross-section of the waterstop in excess of 1/16 inch or 15 percent of material thickness at any point, whichever is less.
- d. Misalignment of the joint which results in misalignment of the waterstop in excess of 1/2 inch in 10 feet.
- e. Porosity in the welded joint as evidenced by visual inspection.
- f. Bubbles or inadequate bonding which can be detected with a penknife test. (If, while prodding the entire joint with the point of a penknife, the

knife breaks through the outer portion of the weld into a bubble, the joint shall be considered defective.)

- g. Visible signs of separation when the cooled splice is bent by hand at any sharp angle.
- h. Evidence of burned material.

1.5 CORRECTION OF DEFECTS

- A. **Waterstops.** If inspections find waterstops to be defective, these joints shall be replaced with material that passes inspection, and faulty material shall be removed from the Site and destroyed.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Joint materials shall be listed as compliant with NSF Standard 61.
- B. Fish Friendly Sealant: Sealants that are required on surfaces that come into contact with fish shall be 3M Marine Adhesive/Sealant Fast Cure 5200 polyurethane sealant; Tremco Vulkem 921 polyurethane sealant; or approved equal.

2.2 WATERSTOPS

A. PVC Waterstops

1. Waterstops shall be extruded from an elastomeric polyvinyl chloride compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the indicated requirements of this Section.
2. No reclaimed or scrap material shall be used.
3. The CONTRACTOR shall obtain from the waterstop manufacturer and shall furnish to the ENGINEER for review, current test reports and a written certification of the manufacturer that the material to be shipped to the Site meets the physical requirements as outlined in the U.S. Army Corps of Engineers Specification CRD-C572-PVC Waterstops, and those indicated.
4. When tested in accordance with the indicated test standards, the waterstop material shall meet or exceed the following requirements:

Physical Property, Sheet Material	Value	ASTM Std
Tensile Strength-min, psi	2,000	D 638, Type IV
Ultimate Elongation-min, percent	350	D 638, Type IV

Low Temp Brittleness, max degrees F	-35	D 746
Stiffness in Flexure, min, psi	600	D 747
Accelerated Extraction (CRD-C572)		
Tensile Strength-min, psi	1,500	D 638, Type IV
Ultimate Elongation, min, percent	300	D 638, Type IV
Effect of Alkalis (CRD-C572)		
Change in Weight, percent	plus 0.25/minus 0.10	-----
Change in Durometer, Shore A	plus and minus 5	D 2240
Finish Waterstop		
Tensile Strength-min, psi	1,400	D 638, Type IV
Ultimate Elongation, min percent	280	D 638, Type IV

5. Flat strip and Center-Bulb Waterstops

- a. Flat strip and center-bulb waterstops shall be manufactured such that at no place shall the thickness of waterstops, including the center bulb type, be less than 3/8 inch.
- b. The waterstop shall be provided with hog rings installed at 12 inches on centers along the waterstop.
- c. Shapes shall be as indicated, or as acceptable to the ENGINEER.

B. **Preformed Hydrophilic Waterstop**

1. Hydrophilic (bentonite-free) waterstops shall be **Hydro-Flex Waterstop** as manufactured by **Henry Co.**, or **Earthshield Type 23**, as manufactured by **JP Specialties**, or equal.
2. The cross-sectional area of the waterstop shall not be less than 0.5 square inch.
3. Hydrophilic waterstop shall be the type that expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.
4. The waterstop shall be manufactured from butyl rubber with hydrophilic properties.

5. The waterstop shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete.
6. The minimum expansion ratio of modified chloroprene shall be not less than 2-to-1 volumetric change in distilled water at 70 degrees F (21 degrees C).
7. The bonding agent for hydrophilic waterstop shall be the manufacturer's recommended adhesive for wet, rough concrete.

C. Other Waterstops

1. When types of waterstops not listed above are indicated, they shall be subjected to the same requirements as those listed in this Section.

2.3 JOINT SEALANT FOR WATER-BEARING JOINTS

- A. The joint sealant shall be a polyurethane polymer designed for bonding to concrete which is continuously submerged in water.
- B. No material will be accepted which has an unsatisfactory history as to bond or durability when used in the joints of water-retaining structures.
- C. Joint sealant material shall meet the following requirements (73 degrees F and 5 percent R.H.):

Work Life, minutes	45 - 180
Time to Reach 20 Shore A Hardness (at 77 degrees F, 200 gram quantity), max	24 hours
Ultimate Hardness (ASTM D 2240, Shore A)	20 - 45
Tensile Strength (ASTM D 412), min	175 psi
Ultimate Elongation (ASTM D 412), minimum	400 percent
Tear Resistance (Die C, ASTM D 624), pounds per inch of thickness, min	75
Color	Light Gray

- D. Polyurethane joint sealants for waterstop joints in concrete shall conform to the following requirements:
 1. Joint sealant shall be 2-part polyurethane with the physical properties of the cured joint sealant conforming to or exceeding the requirements of ASTM C 920 – Elastomeric Joint Sealant, or Federal Specification TT-S-0227 E(3) - Sealing Compound, Elastomeric Type, Multicomponent, for Caulking, Sealing, and Glazing Buildings and Other Structures, for 2-part material, as applicable.

2. For vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used, conforming to the requirements of ASTM C 920, Class 25, Grade NS, or Federal Specification TT-S-0227 E(3), Type II, Class A.
3. For plane horizontal joints, use the self-leveling compounds meeting the requirements of ASTM C 920 Class 25, Grade P, or Federal Specification TT-S-0227 E(3), Type I.
4. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics and having a Shore A hardness range of 35 to 45 shall be used.
5. Primer materials, if recommended by the joint sealant manufacturer, shall conform to the printed recommendations of the manufacturer.

E. Joint Sealant Manufacturers

1. Joint sealants shall be **PSI-270** as manufactured by **Polymeric Systems Inc.**, **Sikaflex 2C**, as manufactured by **Sika Corporation**, or equal.

2.4 JOINT SEALER FOR NON-WATER-BEARING JOINTS

- A. Joint sealer for non-waterstop joints in concrete shall be a material that is composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance that:
1. Does not contain evaporating solvents, or volatile oils/lubricants;
 2. Will tenaciously adhere to concrete surfaces;
 3. Will remain permanently resilient and pliable;
 4. Will not be affected by continuous presence of water;
 5. Will not in any way contaminate potable water;
 6. Will effectively seal the joints against moisture infiltration even when the joints are subjected to movement from expansion and contraction.

2.5 JOINT FILLER

- A. Joint filler for expansion joints in waterholding structures shall be neoprene conforming to ASTM D 1056, Type 2C5-E1.
- B. Joint filler material in other locations shall be of the preformed non-extruding type, constructed of cellular neoprene sponge rubber or polyurethane of firm texture.
- C. Bituminous fiber type will not be accepted.
- D. Non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 - Preformed Sponge

Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction, for Type I, except as otherwise indicated.

- E. **Neoprene Sponge.** The sponge shall be neoprene, closed-cell, expanded, conforming to ASTM D 1056 - Flexible Cellular Materials - Sponge or Expanded Rubber, Type 2C5-E1.

2.6 BACKING ROD

- A. The backing rod shall be an extruded closed-cell, polyethylene foam rod.
- B. The rod material shall be compatible with the joint sealant material, and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi.
- C. The rod shall be 1/8 inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a 3/4-inch wide joint.

2.7 BEARING PAD

- A. The bearing pad shall be neoprene conforming to ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications, BC 420, 40 durometer hardness, unless otherwise indicated.

2.8 SLIP DOWELS

- A. Slip dowels in joints shall be smooth epoxy-coated bars conforming to ASTM A 775 - Epoxy Coated Reinforcing Steel Bars.

2.9 PVC TUBING

- A. PVC tubing in joints shall be SDR 13.5, conforming to ASTM D 2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

PART 3 -- EXECUTION

3.1 GENERAL - WATERSTOPS

- A. Waterstops shall be embedded in the concrete across joints as indicated.
- B. Waterstops shall be fully continuous for the extent of the joint.
- C. Splices necessary to provide such continuity shall conform to the printed instructions of the waterstop manufacturer.
- D. The CONTRACTOR shall take suitable precautions and provide means to support and protect the waterstops during the progress of the WORK, and shall repair or replace any waterstops damaged during progress of the WORK at no additional cost to the OWNER.

- E. Waterstops shall be stored so as to permit free circulation of air around the waterstop material.
- F. When any waterstop is installed in the concrete on one side of a joint while the other portion of the waterstop remains exposed to the atmosphere for more than 2 Days, suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of the sun during the entire exposure time until the exposed portion of waterstop is embedded in concrete.

3.2 SPLICES IN PVC WATERSTOPS

- A. Splices in PVC waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations.
- B. It is essential that:
 - 1. The material shall not be damaged by heat sealing.
 - 2. The splices shall have a tensile strength of not less than 80 percent of the unspliced material.
 - 3. The continuity of the waterstop ribs and of its tubular center axis shall be maintained.
 - 4. No edge welding will be accepted.
- C. Butt joints of the ends of 2 identical waterstop sections may be made while the material is in the forms.
- D. Other Joints
 - 1. Joints with waterstops involving more than 2 ends to be jointed together, and joints that involve an angle cut, alignment change, or the joining of 2 dissimilar waterstop sections, shall be prefabricated prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint.
 - 2. Upon inspection and approval, such prefabricated waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt-welded to the straight run portions of waterstop in place in the forms.
- E. Where a centerbulb waterstop intersects and is jointed with a non-centerbulb waterstop, care shall be taken to seal the end of the centerbulb, using additional PVC material if needed.

3.3 JOINT CONSTRUCTION

A. **Setting Waterstops**

1. In order to eliminate faulty installation that may result in joint leakage, particular care shall be taken as to the correct positioning of the waterstops during installation.
2. Adequate provisions shall be made to support and anchor the waterstops during the progress of the WORK and to ensure proper embedment in the concrete.
3. The symmetrical halves of the waterstops shall be equally divided between the concrete pours at the joints.
4. The center axis of the waterstops shall be coincident with the joint openings.
5. Thoroughly work the concrete in the vicinity of joints for maximum density and imperviousness.

B. Waterstop Placement

1. In placing waterstops in the forms, means shall be provided to prevent them from being folded over by the concrete as it is placed.
2. Waterstops shall be held in place with light wire ties on 12-inch centers, which shall be passed through hog rings at the edge of the waterstop and tied to the curtain of reinforcing steel.
3. Horizontal waterstops, with their flat face in a vertical plane, shall be held in place with continuous supports to which the top edge of the waterstop shall be tacked.
4. In placing concrete around horizontal waterstops with their flat face in a horizontal plane, the concrete shall be worked under the waterstops by hand in order to avoid the formation of air and rock pockets.
5. In placing center-bulb waterstops in expansion joints, the center-bulb shall be centered on the joint filler material.
6. Waterstop in vertical wall joints shall terminate 6 inches from the top of the wall, where such waterstop does not connect with any other waterstop and is not to be connected to a future concrete placement.

C. Joint Location

1. Construction joints and other types of joints shall be provided where indicated.
2. If not indicated, construction joints shall be provided at a 25-foot maximum spacing.
3. Where joints are indicated to be spaced greater than 40 feet apart, additional joints shall be provided to maintain the 25-foot maximum spacing.

4. The location of joints, regardless of type, shall be submitted for acceptance by the ENGINEER.

D. Joint Preparation

1. **Construction Joints:** The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of laitance, loose or defective concrete, foreign material, and be roughened to a minimum of 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing. Pools of water shall be removed from the surface of construction joints before the new concrete is placed. The following is also required:
 - a. Special care shall be used in preparing concrete surfaces at joints where bonding between 2 sections of concrete is required.
 - b. Unless otherwise indicated, such bonding shall be required at every horizontal joint in walls.
2. **Old Concrete:** Where concrete is to be cast against old concrete (defined as any concrete which is greater than 60 Days old), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting or sandblasting to expose aggregate. The joint surface shall be coated with an epoxy bonding agent unless determined otherwise by the OWNER. This provision shall not apply to joints where waterstop is provided.

E. Joint Sealant

1. Crack control joints in water-bearing floor slabs and elsewhere as indicated shall be provided with tapered grooves which shall be filled with a joint sealant, as indicated.
2. The material used to form the tapered grooves shall be left in the grooves until just before the grooves are cleaned and filled with joint sealant.
3. After removing the forms from the grooves, laitance and fins shall be removed, and the grooves shall be sand blasted.
4. The grooves shall be allowed to thoroughly dry, after which they shall be blown out and immediately thereafter they shall be primed and filled with the construction joint sealant.
5. No joint sealant shall be used without a primer. The primer and sealant shall be placed strictly in accordance with the printed recommendations of the manufacturer, taking special care to properly mix the sealant prior to application.

6. The sides of the sealant groove shall not be coated with bond breaker, curing compound, or any other substance which would interfere with proper bonding of the joint sealant.
7. Care shall be used to completely fill the sealant grooves.
8. The joint sealant shall be installed by a competent waterproofing specialty contractor with a successful record of performance in similar installations.
9. The joint sealant shall achieve final cure at least 7 Days before the structure is filled with water.

10. Mixing

- a. Catalyst-cured, 2-part materials shall be thoroughly and uniformly mixed, and special care shall be taken to properly mix the sealer before its application.
- b. Before any sealer is placed, the CONTRACTOR shall arrange to have workers performing the WORK carefully instructed on the proper method of mixing and application by a representative of the joint sealant manufacturer.

11. Failure to Cure

- a. Any joint sealant that fails to fully and properly cure after the manufacturer's recommended curing time for the conditions of the WORK shall be completely removed, and the groove shall be thoroughly sandblasted to remove traces of the uncured or partially cured sealant and primer.
- b. The groove shall be re-sealed with the indicated joint sealant.
- c. Costs of such removal, joint treatment, re-sealing, and appurtenant WORK shall be the CONTRACTOR's responsibility as part of the WORK.

F. Hydrophilic Waterstop

1. Where a hydrophilic waterstop is indicated, it shall be installed in accordance with the manufacturer's instructions and recommendations except as may be modified in this Section.
2. When requested by the ENGINEER, the CONTRACTOR shall arrange for the manufacturer to furnish technical assistance in the field.
3. Hydrophilic waterstop shall only be used where complete confinement by concrete is provided.
4. Hydrophilic waterstop shall not be used in expansion or contraction joints nor in the first 6 inches of a non-intersecting joint.

5. **Location**

- a. The hydrophilic waterstop shall be located as near as possible to the center of the joint, and it shall be continuous around the entire joint.
- b. The minimum distance from the edge of the waterstop to the face of the member shall be 5 inches.

6. **Placement**

- a. Where the thickness of the concrete member to be placed on the hydrophilic waterstop is less than 12 inches, the waterstop shall be placed in grooves formed or ground into the concrete.
 - b. The groove shall be at least 3/4 inch deep and 1-1/4 inches wide.
 - c. When placed in the groove, the minimum distance from the edge of the waterstop to the face of the member shall be 2-1/2 inches.
7. Where a hydrophilic waterstop is used in combination with PVC waterstop, the hydrophilic waterstop shall overlap the PVC waterstop for a minimum of 6 inches and shall be adhered to PVC waterstop by a single component water-swelling sealant as recommended by the manufacturer.
8. The hydrophilic waterstop shall not be installed where the air temperature falls below the manufacturer's recommended range.

9. **Preparation**

- a. The concrete surface under the hydrophilic waterstop shall be smooth and uniform, and the concrete shall be ground smooth if needed.
- b. Alternatively, the hydrophilic waterstop shall be bonded to the surface using an epoxy grout that completely fills voids and irregularities beneath the waterstop material.
- c. Prior to installation, the concrete surface shall be wire brushed to remove any laitance or other materials that may interfere with the bonding of epoxy.

10. **Securing**

- a. The hydrophilic waterstop shall be secured in place with concrete nails and washers at 12-inch maximum spacing.
- b. The above requirement shall be in addition to the adhesive recommended by the manufacturer.

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SECTION 03 41 10 - STRUCTURAL PRECAST CONCRETE

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall furnish all tools, equipment, materials, and supplies and shall perform all labor required to complete the precast concrete work in accordance with the Contract Documents.
- B. This Section covers the design, fabrication, delivery and installation of all precast concrete units, including connections, complete, in place, as shown and specified.

1.2 REFERENCES. Unless noted otherwise, the latest version of each References is applicable to the WORK.

- A. ANSI/ACI 315 Concrete Reinforcement
- B. ANSI/ACI 318 Concrete Construction
- C. AWS A5.4 Welding Rods and Electrodes
- D. AWS D1.1 Welding and Cutting
- E. ASTM A 184 Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
- F. ASTM A 185 Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
- G. ASTM A 193 Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
- H. ASTM A 194 Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
- I. ASTM A 351 Steel Castings, Austenitic, for High-Temperature Service
- J. ASTM A 497 Welded Deformed Steel Wire Fabric for Concrete Reinforcement
- K. ASTM A 580 Stainless and Heat-Resisting Steel Wire
- L. ASTM A 615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- M. ASTM A 666 Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications
- N. ASTM C 33 Concrete Aggregates
- O. ASTM C 67 Method for Sampling and Testing Brick and Structural Clay Tile
- P. ASTM C 127 Test Method for Specific Gravity and Absorption of Coarse Aggregate

- Q. ASTM C 128 Test Method for Specific Gravity and Absorption of Fine Aggregate
- R. ASTM C 150 Portland Cement
- S. ASTM C 173 Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
- T. ASTM C 204 Test Method for Fineness of Portland Cement by Air Permeability Apparatus
- U. ASTM C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- V. ASTM C 260 Air-Entraining Admixtures for Concrete
- W. ASTM C 311 Method for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete
- X. ASTM D 2240 Test Method for Rubber Property -- Durometer Hardness
- Y. AWS D12.1 Steel Reinforcing Bars
- Z. PCI MNL-116 Quality Control for Structural Precast Products
- AA. PCI MNL-117 Quality Control for Architectural Precast Products

1.3 CONTRACTOR SUBMITTALS

- A. Submittals shall be made in accordance with Section 01 33 00 - Contractor Submittals.
- B. Shop Drawings:
 - 1. Shop Drawings shall show details in accordance with ACI 315 and ACI 318 including installation details and design computations.
 - 2. Shop drawings, including design computations, shall be stamped and signed by a structural engineer registered in the State and shall be approved by the ENGINEER.
 - 3. Shop Drawings shall indicate precast unit identification marks, location of units in the WORK, elevations, fabrication details, welding details, reinforcement, connections, dimensions, interface with adjacent members, and special handling instructions in sufficient detail to cover manufacture, handling, and erection. Shop Drawings shall include erection drawings.
 - 4. Shop Drawings shall be divided into complete separate submittals for each structure. Shop drawings shall show all elevations, dimensions, horizontal and vertical sections, openings, inserts, reinforcing, anchorage devices, details, design computations, and other requirements for each different type of element to be incorporated into the portion of the project covered by the submittal. Drawings shall be 24 inches x 36 inches maximum.

- C. **Mix Proportions:** Prior to commencing operations, including fabrications of the precast for any mock-up, a statement shall be submitted giving the nominal maximum aggregate size and proportions of all ingredients that will be used in the manufacture of concrete. The statement shall include test results from an approved testing laboratory, certifying that the proportions selected will produce concrete of the properties required. No substitutions shall be made in materials used in the concrete mix without approval and additional tests to verify that the concrete properties are satisfactory. A copy shall be submitted of concrete mix with each set of samples.
- D. **Test Reports:** Tests for compressive strength of concrete shall be performed by an independent commercial testing laboratory. Copies of test reports including all test data and all test results shall be submitted.
- E. **Certificates of Compliance:** Certificates of compliance shall be submitted attesting that materials and products meet or exceed specified requirements.
- F. **Manufacturer's Qualifications:** Prior to commencing operations, a statement shall be submitted giving the qualifications of the precast concrete manufacturer, and evidence that the manufacturer and plant are PCI certified.

1.4 QUALITY CONTROL

- A. **General Requirements:** Design members under direct supervision of a professional structural engineer experienced in design of precast concrete units, registered in the State and conforming to requirements of PCI MNL-121 and to ACI 318.
 - 1. Precast manufacturer and erectors shall be qualified in accordance with PCI MNL-117.
 - 2. Welding shall be in accordance with AWS D1.1, AWS D12.1, AWS B2.1, and AWS A5.4.
 - 3. **Manufacture, Transportation and Installation:** The manufacturer shall specialize in providing architectural precast products and services normally associated with precast concrete construction with high quality architectural finishes similar to that indicated on drawings, using procedures complying with PCI MNL-116 and PCI plant certified for at least 2 years.

1.5 DESIGN REQUIREMENTS

- A. **General:** The precast concrete unit and connection designs shown represent minimum precast construction requirements. The manufacturer shall verify the precast unit and connection designs for all handling, erection, and service conditions, and shall provide any additional materials necessary to meet the design conditions.
- B. **Standards and Loads:** The precast unit and connection design and construction shall conform to all applicable codes and AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

- C. **Concrete Mix:** The concrete mix shall be designed by the manufacturer and approved by the ENGINEER, using the materials and quantities specified to meet all of the requirements of this specification.
1. Proportioning of Concrete Mixes: Mixes shall be proportioned by weight except water and admixtures may be batched by volume if desired. Trial mixes and testing to meet requirements of the strengths of concrete specified is the CONTRACTOR's responsibility. Design mix shall contain similar materials as those proposed for use in the WORK.
 2. Admixtures: Concrete shall contain an air entraining admixture in proportion so as to provide 4 percent plus or minus 1 percent total air in the concrete as determined by ASTM C 173 or C 231. Set retarding admixtures may be used provided cement content is not reduced. Water reducing admixtures may be used provided they are used in the mix design studies. High-range water reducers (superplasticizers) shall be used only where specifically called for in this Section, otherwise superplasticizers shall not be used without written approval from the ENGINEER. No admixture may contain chlorides, bromides, or fluorides.
 3. Water: Clean, potable water. The CONTRACTOR shall provide tests to assure that no more than 200 parts per million total aggregated content of chlorides, bromides, and fluorides are present.
- D. **Formwork:** Formwork shall be designed to withstand high-frequency vibration and to ensure finished units.

1.6 DELIVERY, STORAGE AND HANDLING

- A. **General:** Precast members shall be handled to position consistent with their shape and design; they shall be lifted and supported from design incorporated support points and provided with strong backs and other devices as required. Lifting or handling equipment shall be capable of maintaining units during manufacture, storage, transportation, erection, and in position for fastening.
- B. Blocking and supports, lateral restraints and protective materials during transport and storage shall be clean, nonstaining, without causing harm to exposed surfaces, including temporary support to prevent bowing and warping. Lateral restraints shall be provided to prevent undesirable horizontal movement. Edges and exposed faces of members shall be protected to prevent straining, chipping, or spalling of concrete.
- C. Units shall be marked with date of production and final position in structure in location not visible after erection.
- D. Precast units shall be stored off the ground in a manner to prevent warpage and they shall be protected from weather, marring, and overload.
- E. **Stainless Steel Hardware:** Stainless steel hardware shall be transported, handled, stored, and protected in wood crates.

PART 2 -- PRODUCTS

2.1 CONCRETE MATERIALS

Cement	ASTM C 150, Type II, "low alkali," white color. "Low alkali" requirement may be waived if not reactive as defined in Appendix to ASTM C 33. Submit laboratory test reports.
Aggregate	ASTM C 33, 1/2-inch max coarse aggregate size fine aggregate ratio to total aggregate volume = 0.35 min, 0.55 max.
Water Absorption, Coarse Water Absorption, Fine	ASTM C 127 ASTM C 128
Reinforcing Steel	ASTM A 615, Grade 60, deformed epoxy coated in accordance with ASTM A 775
Welded Wire Fabric Plain Deformed Steel Fabricated Steel Bar or Rod Mats	ASTM A 185, epoxy-coated ASTM A 497, epoxy-coated ASTM A 184, epoxy-coated
Tie Wire	ASTM A 580, Type 316L, cold finished annealed, Huntington Alloy Co. "Monel" or "Inconel."
Air Entrainment Admixture	ASTM C 260
Water Reducing or Retarding Admixtures	ASTM C 494, Type C, D, or F/G, with no chloride, bromide, and fluoride ingredients
Silica Fume Slurry Admixture	45 to 50 percent silica fume, water, and superplasticizer as dispersant. Silica Fume: 85 percent amorphous silicon dioxide in accordance with ASTM C 311; loss on ignition shall not exceed 6 percent and moisture shall not exceed 3 percent in accordance with ASTM C 311. Surface area not less than 10,000 square meters per kilogram at bed porosity of 0.50 in accordance with ASTM C 204 Reduce water in mix by 5.6 to 9.5 lbs for each

	gallon of slurry added to mix, as recommended by slurry manufacturer used.
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2.2 SUPPORT DEVICES

Connecting and Support Devices	ASTM A 666, Type 316L stainless steel
Bolts	ASTM A 193, Grade B8M (Type 316)
Nuts and Washers	ASTM A 194, Grade 8M (Type 316)
Weld Filler Metal for Stainless Steel	Stainless steel to stainless steel; AWS A5.4, Grade 316L filler metal; stainless steel to carbon steel, AWS A5.4, Grade 309 filler metal, 3/32-inch diameter
Primer	Zinc-dust, zinc oxide primer in a phenolic resin spare varnish vehicle, TT-P-641 Type III (for galvanized surfaces)

2.3 ACCESSORIES

Plates, Angles, Anchors, and Studs	ASTM A 666, Type 316L stainless steel
Austenitic Steel Castings for Embedments and Anchorage Assemblies	ASTM A 351, Type CF3M, with Type 316 stainless steel bolts, nuts, and washers
Reglets	Plastic, shaped and flanged to remain in place once cast; tape closed to prevent concrete intrusion
Bearing Pads	Neoprene, molded to size or cut from molded sheet, 70-80 Type A durometer, ASTM D 2240
Sealant	Specified in Section 07920 - Sealants and Caulking

2.4 FORMS

Forms	Manufacturer's standard with smooth, hard, dense, and rigid casting surface; without bow, warpage, oil canning, or other imperfections
Form Release Agent	Manufacturer's standard, nonstaining, nonpetroleum based; compatible with concrete surface sealer
Surface Sealer	Clear, flat, penetrating, nonyellowing, nonclouding solution; high concentration of organosilane in an aqueous alcoholic vehicle which is designed to provide water repellent concrete surfaces from which graffiti can be easily removed. Oil-type silicones, paraffins, waxes, vinyls, modified urethanes, or acrylics shall not be used. Sealant shall be tested by manufacturer and proved compatible with surface sealer

2.5 FABRICATION

A. General:

1. Precast concrete units shall be fabricated by a licensed shop in accordance with ACI 318, PCI MNL-116 (structural features), PCI MNL-117 (nonstructural features, surface treatments, patching, and tolerances). Plant records and quality control program shall be maintained during production of precast units. Records and access to plant shall be available to the ENGINEER upon request.
2. Rigid molds shall be used, constructed to maintain precast unit uniform in shape, size, and finish, free from castings and dents, gouges, oil canning, or other irregularities that will adversely affect appearance or strength of units. Consistent quality shall be maintained during manufacture.
3. Equipment for handling epoxy-coated reinforcing bars shall have protected contact areas. Bundles of coated bars shall be lifted at multiple pickup points to prevent bar-to-bar abrasion from sags in the bundles. Coated bars or bundles of coated bars shall not be dropped or dragged. Coated bars shall be stored on protective cribbing. The maximum amount of damage shall not exceed 2 percent of the surface area of each bar.
4. Reinforcing steel, anchors, inserts, plates, angles, and other cast-in-place items shall be embedded as indicated on shop drawings. Reinforcement shall be fabricated and placed in conformance with ACI 318. No tack welding of or to reinforcement permitted. Welding when allowed shall conform to AWS D1.4 requirements. No carbon steel chairs, spacers, nails or tie wire shall be used in positioning reinforcing and embedments.

5. Adequate reinforcing steel shall be provided to control cracking. Maximum permissible crack width:
 - a. Surfaces exposed to weather: 0.005 inch
 - b. Surfaces exposed to view but not weather: 0.01 inch
6. Connecting devices, plates, angles, items fit to steel framing members, inserts, bolts, and accessories shall be fabricated to permit initial placement and final attachment.
7. Anchors, inserts, lifting devices, and other accessories shall be placed and embedded in accordance with approved shop drawings, accurately positioned in their designed location and anchored to prevent dislocation during precast unit construction. Flashing reglets shall be placed and embedded continuous and straight, with lifting devices to permit removal after erection.
8. Units shall be moist cured with water mist to develop concrete quality and to minimize surface drying and appearance blemishes such as nonuniformity, staining, or surface cracking.
9. Precast units shall be removed from formwork using procedures conforming to PCI MNL-117. Minor patching in plant acceptable, providing structural adequacy and appearance of units are not impaired. Each precast unit shall be identified with corresponding code on erection drawings, in location not visible to finished work.
10. Repair of damaged epoxy coating, when required, shall be made with patching material conforming to ASTM A 775. Repair shall be in accordance with the material Manufacturer's recommendations.

B. Fabrication and Tooling of Stainless Steel Connections and Embedments:

1. All tools used during fabrication shall be made of stainless steel. Use of carbon steel tools is prohibited.
2. Welding of stainless steel shall conform to AWS A5.4, AWS B2.1 and AWS D1.1, using tungsten inert gas procedures and 316L filler metal for stainless steel to stainless steel and 309 filler metal for stainless steel to carbon steel. Surfaces shall be sanded smooth (do not grind), and oxidized discoloration removed (blue heat tint). Threaded parts of stainless steel bolts shall be lubricated with graphite suspended in alcohol (**Neo-Lube**) every time that nut is run on or off the threads. No other lubricant is acceptable.
3. Erection slings, cables, blocking, hardware and restraints shall be nonmetallic or stainless steel. Cribbing or crating shall be wood.

2.6 FINISH OF PRECAST UNITS

- A. **Backs and Sides (Unexposed Edges):** Smooth, dense, uniform surface free from blemishes. Defects in backs and sides (unexposed edges) shall be repaired as approved.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. **Examination:** The CONTRACTOR shall verify that building structure, anchors, devices, and openings are ready to receive work of this Section. Beginning of installation means acceptance of existing condition.
- B. **Preparation:** The CONTRACTOR shall provide for erection procedures and induced loads, during erection, maintain temporary bracing in place until final support is provided, provide necessary hoisting equipment and safety and protective devices.
- C. Erection:
1. The units shall be erected in accordance with approved shop/erection drawings without damage to shape or finish or adjacent work. Damaged precast units shall be replaced or repaired. Unless otherwise shown, members shall be erected level and plumb within allowable tolerances.
 2. The CONTRACTOR shall align and maintain uniform horizontal and vertical joints as erection progresses, provide approved shims and wedges as required, and when members required adjustment beyond design or tolerance criteria, discontinue affected work. Units shall be secured in place and field welds, scratches and otherwise damaged steel surfaces shall be touched up.
 3. Field fabrication and erection of stainless steel shall conform to the procedures outlined in the paragraph entitled "Fabrication and Tooling of Stainless Steel Connectors and Embedments."
 4. The vertical units shall be set dry, without grout, attaining joint dimension with lead or plastic shims and spacers.
 5. Pickup points, boxouts, inserts and bearing surfaces shown shall be grouted with non-shrink grout in accordance with Section 03315 - Grout. The color and texture of concrete surfaces of adjacent areas shall be finished to match in the same plane.
- D. **Tolerances:** In accordance with requirements of PCI MNL-117 unless otherwise indicated.
1. Variation from Plane of Location: 1/4-inch in 10 feet and 3/8-inch in 100 feet maximum, compensating not cumulative.
 2. Offset from True Alignment between Two Connecting Members: 1/4-inch maximum.
 3. Out of Square: 1/8-inch in 10 feet maximum, noncumulative.
 4. Variation in Dimensions Indicated in Shop Drawings: Plus or minus 1/8-inch.
 5. Misalignment of Anchors, Inserts, Openings: 1/8-inch, maximum.
 6. Bowing or Warpage of Units: 1/700 of panel dimension.

7. Exposed Joint Dimension: 3/4-inch plus or minus 1/8-inch.

8. Location of Reglets: 1/4-inch from true position.

E. **Joint Sealing:** Specified in Section 07920 - Sealants and Caulking.

3.2 CLEANING

A. Not sooner than 72 hours after joints are sealed, faces and other exposed surfaces of precast units shall be cleaned using a cleaning detergent recommended by the sealer manufacturer and water applied with a soft bristle brush, and thoroughly rinsed using clean water or other approved procedures.

B. Units shall be cleaned when temperature and humidity conditions are such that surfaces dry rapidly (e.g., 70 degrees F and rising, 50 percent RH or less).

C. Discolorations which cannot be removed by these procedures shall be considered defective work, and repaired or replaced as directed by ENGINEER.

3.3 PROTECTION

A. Adjacent surfaces shall be protected from damage during sealing and cleaning operations and against damage, disfiguration or discoloration from subsequent operations. Noncombustible shielding shall be used during welding operations.

- END OF SECTION -

SECTION 03 60 00 – CEMENTITIOUS GROUT

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide grout, complete and in place, in accordance with the Contract Documents
- B. **Grout Types.** The following types of grout are covered in this Section:
 - 1. Cement Grout
 - 2. Non-Shrink Grout - Class II (cement-based)

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the Contract.
 - 1. Certification that grouts used on the project contain no chlorides or other chemicals that cause corrosion.
 - 2. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the WORK, and location of use.
 - 3. Manufacturer's certification that its non-shrink grout does not contain aluminum, zinc, or magnesium powders as a method of expansion.

PART 2 -- PRODUCTS

2.1 APPLICATION

- A. Unless indicated otherwise, grouts shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Grout
Grout fill greater than 3-inches thick	Structural Concrete per 03 30 00
Surface repairs	Cement Grout
Under precast concrete elements	Non-Shrink Class II
Repair of holes and defects in concrete members which are water bearing or in contact with soil or other fill materials	Non-Shrink Class II

Any application not listed above, where grout is indicated	Non-Shrink Class I, unless specifically indicated otherwise (Non-Shrink Class II is an approved substitute for any use designated as Non-Shrink Class I)
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2.2 CEMENT GROUT

- A. Cement grout shall be composed of one part cement, 3 parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 Days shall be 4,500 psi.
- B. Cement grout materials shall be as indicated in Section 03 30 00 - Cast-in-Place Concrete.

2.3 NON-SHRINK GROUTS (Cement-based)

A. **General**

1. Cement-based non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.
2. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout shall be as recommended by the manufacturer for the particular application.
3. Grout shall not contain chlorides or additives that may contribute to corrosion.
4. Grout shall be formulated to be used at any consistency from fluid to plastic.
5. The grout when tested shall not bleed or segregate at maximum allowed water content.
6. Grout shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827.
7. Grout shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090.
8. Provide certification that its non-shrink property is not based on gas production or gypsum expansion.
9. Class II non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C 939.
10. Cement-based non-shrink grout shall have the following minimum properties when tested at a fluid consistency, at 28 Days:

- a. Minimum tensile splitting strength of 500 psi per ASTM C 496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
- b. Minimum flexural strength of 1000 psi per ASTM C 580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
- c. Minimum bond strength (concrete to grout) of 1900 psi per modified ASTM C 882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
- d. Grout shall be certified for use in freeze/thaw environments.

B. Class I Non-Shrink Grout

1. Class II non-shrink grout shall be a high precision, fluid, extended working time, grout. The minimum 28-Day compressive strength shall be 5000 psi, when mixed at a fluid consistency.
2. Class II non-shrink grout shall be **Masterflow 713 Plus** by **BASF**, **Five Star Grout** by **Five Star Products**, **Premier** by **L&M Construction Chemicals**, or approved equal.

C. Class II Non-Shrink Grout

1. Class II non-shrink grout shall be a high precision, fluid, extended working time, grout. The minimum 28-Day compressive strength shall be 7500 psi, when mixed at a fluid consistency.
2. Class II non-shrink grout shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C 827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C 1107.
3. Class II non-shrink grout shall be **Masterflow 928** by **BASF**, **Five Star Fluid Grout 100** by **Five Star Products**, **Crystex** by **L&M Construction Chemicals**, or approved equal.

2.4 CURING MATERIALS

- A. Curing materials shall be in accordance with Section 03 30 00 - Cast-in-Place Concrete for Cement Grout. Curing materials shall be in accordance with the manufacturer's recommendations for prepackaged grouts.

2.5 CONSISTENCY

- A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is defined such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.

2.6 MEASUREMENT OF INGREDIENTS

- A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurements shall not be allowed.
- B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Grout shall be stored in accordance with manufacturer's recommendations.

3.2 GENERAL

- A. CONTRACTOR shall arrange for the manufacturer of prepackaged grouts to provide on-Site technical assistance within 72 hours of request, as part of the WORK.
- B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the ENGINEER.
- C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.
- D. Surface preparation, curing, and protection of cement grout shall be in accordance with Section 03 30 00 - Cast-in-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.
- E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.
- F. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.
- G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.3 GROUTING PROCEDURES

- A. **General:** Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

3.4 CONSOLIDATION

- A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

3.5 CURING

- A. Cement based grouts shall be cured per Section 03 30 00 - Cast-in-Place Concrete and per the manufacturer's recommendations.

- END OF SECTION -

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SECTION 03 65 00 – ADHESIVE GROUT SYSTEMS

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide adhesive systems, complete and in place, in accordance with the Contract Documents. These products have been historically called epoxy resins, but may include other formulations that adhere embedded material into drilled concrete. When it occur in this Section, the term “epoxy grout” is understood to be an adhesive system capable of installing drilled anchors and/or reinforcement.
- B. **Adhesive Systems.** The following types of adhesive grout are covered in this Section:
 - 1. Epoxy Anchor Grout for Adhesive Anchors
 - 2. An alternative (non-epoxy based) formulation approved by the ENGINEER.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the Contract.
 - 1. Certification that grouts used on the project contain no chlorides or other chemicals that cause corrosion.
 - 2. Manufacturer’s literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the WORK, and location of use. ICC report shall be submitted for epoxy anchor grout for adhesive anchors.
 - 3. Submit manufacturer's written warranty as indicated herein.

1.3 QUALITY CONTROL

- A. **Epoxy Anchor Grout for Adhesive Anchors**
 - 1. The installer shall be certified by a manufacturer's representative to install the adhesive system for the conditions at the Site, or be under the direct and continuous supervisor of a CONTRACTOR’s employee that is currently certified, and a copy of the certificate shall be filed with the CONTRACTOR and be submitted to the ENGINEER.

PART 2 -- PRODUCTS

2.1 APPLICATION

- A. Unless indicated otherwise, grouts shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Grout
Drilled-in Anchor bolts and Reinforcing Steel	Adhesive System

2.2 ADHESIVE SYSTEM (EPOXY ANCHOR) GROUT

- A. Epoxy anchor grout shall conform to ASTM C 881 - Epoxy-Resin-Base Bonding Systems for Concrete, Type IV, Class A, B and C, Grade 3 with the exception of gel time.
- B. Heat deflection temperature per ASTM D 648 -- Test Method for Deflection Temperature of Plastics Under Flexural Load shall be a minimum 120 degrees F.
- C. Manufacturer shall certify that the epoxy anchor grout will maintain 90 percent of its strength up to a temperature of 125 degrees F.
- D. Grout shall come in a 2 chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The grout shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.
- E. Epoxy anchor grout shall be capable of being used in submersed applications once cured.
- F. Compressive strength per ASTM D 695 - Test Method for Compressive Properties of Rigid Plastics shall be 10,000 psi minimum.
- G. Whenever possible, overhead anchors subject to vibration, anchors in fire-resistive construction or high fire risk areas, and anchors subject to working or operating temperatures above 100 degrees F shall be cast-in-place anchors. Whenever cast-in-place anchors cannot be used in these applications, use cement based non-shrink grout and oversized holes.
- H. Embedment of adhesive anchors/rebar shall be deep enough to develop the anchor/rebar. Embedment shall not exceed 67 percent of the member depth.
- I. Epoxy anchor grout shall be **HIT HY 200** by **Hilti**, or approved equal.

2.3 CURING MATERIALS

- A. Curing materials shall be in accordance with recommendations by the manufacturer of prepackaged grouts.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Grout shall be stored in accordance with manufacturer's recommendations.

3.2 GENERAL

- A. Grout shall not be placed until base concrete has attained its design strength, unless authorized otherwise by the ENGINEER.

- B. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.
- C. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.
- D. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.3 GROUTING PROCEDURES

- A. **General:** Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for adhesive systems shall be done according to the instructions and recommendations of the manufacturer.

3.4 CURING

- A. Adhesive systems shall be cured per the manufacturer's recommendations.

- END OF SECTION -

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SECTION 05 50 00 - MISCELLANEOUS METALWORK

PART 1 -- GENERAL

1.1 SUMMARY

The CONTRACTOR shall provide miscellaneous metalwork and appurtenances, complete and in place, as indicated in accordance with the Contract Documents.

1.2 REFERENCES. Unless noted otherwise, the latest version of each References is applicable to the WORK.

- A. MIL-A-907E Anti-seize Thread Compound, High Temperature
- B. AISC Manual of Steel Construction
- C. ANSI / AWS D1.1 Structural Welding Code – Steel
- D. ANSI / AWS D1.2 Structural Welding Code – Aluminum
- E. ANSI / AWS QC1 Qualification and Certification of Welding Inspectors
- F. ASTM A 36 Carbon Structural Steel
- G. ASTM A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- H. ASTM A 123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- I. ASTM A 153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- J. ASTM A 193 Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
- K. ASTM A 194 Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service
- L. ASTM A 307 Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
- M. ASTM A 325 Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
- N. ASTM A 500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- O. ASTM A 992 Steel for Structural Shapes for Use in Building Framing

1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Shop Drawings

1. Shop Drawings shall conform to AISC recommendations and specifications, and shall show holes, and the like, as may be required for other parts of the WORK.
2. Shop Drawings shall include complete details of members and connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.
3. **Grating:** Submit layout drawings for grating, showing the direction of span, type and depth of grating, size and shape of grating panels, support seat angle and ledger details, and details of grating hold down fasteners. Submit load and deflection tables for each style and depth of grating used.

1.4 QUALITY CONTROL

- A. Weld procedures and welder qualifications shall be available upon request by the ENGINEER.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Steel:

1. W-Shapes and Channels: ASTM A 992
2. Shapes, Plates, Bars: ASTM A 36
3. Pipe, Pipe Columns, Bollards: ASTM A 53, Type E or S, Grade B standard weight unless indicated otherwise
4. Hollow Steel Sections (HSS): ASTM A 500 Grade B

- B. **Corrosion Protection:** Unless otherwise indicated, fabricated steel metalwork which will be used in a corrosive environment and/or will be submerged in water or wastewater shall be hot dipped galvanized after fabrication.

- C. **Stainless Steel:** Stainless steel metalwork and bolts shall be fabricated from Type 304 or 316 stainless steel.

- D. **Aluminum:** Unless otherwise indicated, aluminum metalwork shall be fabricated from Alloy 6061-T6.

2.2 METAL GRATING

- A. Metal grating shall be of the indicated design, size, and type.
- B. Grating shall be supported around an opening by support members.

- C. Where grating is supported on concrete, unless otherwise indicated provide embedded support angles that match the grating material and are mitered and welded at their corners.
- D. **Banding:** The grating shall be completely banded at edges and cutouts. The banding material and cross-section shall be equivalent to the bearing bars. The banding shall be welded to each cut bearing bar.
- E. The grating pieces shall be fastened to each support in two (2) locations.
- F. Where grating forms the landing at the top of a stairway, the edge of the grating that forms the top riser shall have an integral non-slip nosing with a width equal to that of the stairway.
- G. Where the grating depth is not indicated, provide grating within allowable stress levels and which shall not exceed a deflection of ¼-inch or the span divided by 180, whichever is less.
- H. For standard duty plank and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 psf, whichever is greater, or a concentrated load of 600 pounds.
- I. **Material:** Except where indicated otherwise, grating shall be fabricated entirely of galvanized steel.
- J. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise.
- K. Standard duty grating shall be composed of serrated bar grating.
- L. Cross bars shall be welded or mechanically locked tightly into position such that there is no movement between the bearing and cross bars.
- M. **Safety Grating:** When permitted by the ENGINEER, safety grating shall be fabricated from sheet metal punched into an open serrated diamond pattern and be formed into plank sections. The open diamond shapes shall be approximately 1.875-inches by 11/16-inches in size. Safety grating shall be **Grip Strut** by **Metal Products Division, United States Gypsum Company**, **Deck Span** by **IKG Industries**, or equal.
- N. **Plank Grating:** When permitted by the ENGINEER, plank grating shall be extruded in 6-inch widths with a minimum of six (6) integral one-bar type bearing bars per plank. The top surface shall be solid with raised ribs, unless indicated otherwise. Where punched grating is required, the top surface shall be provided with a pattern of 3-inch by 19/32-inch rectangular openings spaced at 4-inches on-center. The planks shall have a continuous tongue-and-groove type interlock at each side, except that interlocking planks shall be arranged such that any 4-foot wide section may be removed independently from the other grating sections.

2.3 BOLTS AND ANCHORS

A. **Standard Service (Non-Corrosive Application):**

- 1. Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be fabricated from carbon steel as indicated, and hot dip galvanized after fabrication.

2. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing.
3. Except as otherwise indicated, steel for bolt material, anchor bolts, and cap screws shall be in accordance with the following requirements:
 - a) Structural Connections: ASTM A 307, Grade A or B, hot-dip galvanized
 - b) Anchor Bolts: ASTM A 307, Grade A or B, or ASTM A 36, hot-dip galvanized
 - c) High-Strength Bolts, where indicated: ASTM A 325
 - d) Pipe and Equipment Flange Bolts: ASTM A 193, Grade B-7

B. Corrosive Service

1. Bolts, nuts, and washers in the locations listed below shall be fabricated from Type 316 stainless steel as indicated below, or as indicated otherwise on the Contract Drawings.
 - a) Buried locations
 - b) Submerged locations
 - c) Locations subject to seasonal or occasional flooding, unless indicated as galvanized on the Contract Drawings.
 - d) Inside hydraulic structures below the top of the structure
 - e) Locations indicated or designated by the ENGINEER to be provided with corrosion resistant steel bolts
2. **Stainless Steel Nuts on SS Bolts.** Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be fabricated from Type 316 stainless steel, Class 1, conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts.
3. **Anti-seize Lubricant Coating:** Threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, meeting government specification MIL-A-907E.
4. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.
5. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.
6. Antiseize lubricant shall be "PURE WHITE" by **Anti-Seize Technology; AS-470** by **Dixon Ticonderoga Company;** or approved equal.
7. **Bolt Requirements:**
 - a) The bolt and nut material shall be free-cutting steel.
 - b) The nuts shall be capable of developing the full strength of the bolts.

- c) Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.
- d) Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.
- e) Bolts and nuts shall be installed with washers fabricated from material matching the base material of bolts, except that hardened washers for high-strength bolts shall conform to the requirements of the AISC Specification.
- f) Lock washers fabricated from material matching the bolts shall be installed where indicated.
- g) The length of each bolt shall be such that the bolt extends at least 1/8-inch beyond the outside face of the nut before tightening, except for anchor bolts which shall be flush with the face of the nut before tightening.

2.4 DRILLED ANCHORS IN CONCRETE

A. **General:**

- 1. Unless otherwise indicated, drilled concrete anchors shall be adhesive anchors.
- 2. No substitutions will be considered unless accompanied with an ICBO report verifying strength and material equivalency.
- 3. Expanding type anchors are not permitted unless specifically indicated otherwise in the Contract Documents.
- 4. The adhesive system shall be in accordance with the requirements of Section 03 65 00 – Adhesive Grout Systems.
- 5. Threaded rod shall be galvanized for general purpose applications and fabricated from Type 316 stainless steel for use in corrosive applications.
- 6. Embedment depth shall be as the manufacturer recommends for the load to be supported.

PART 3 -- EXECUTION

3.1 FABRICATION AND INSTALLATION REQUIREMENTS

A. **Fabrication and Erection**

- 1. Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

3.2 WELDING

A. **Methods & Qualifications**

1. Welding shall be performed by the metal-arc method or gas-shielded arc method as described in the American Welding Society "Welding Handbook" as supplemented by other pertinent standards of the AWS.
2. The qualification of the welders shall be in accordance with the AWS Standards.

B. Quality:

1. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained in order to minimize distortion and for control of dimensions.
2. Upon completion of welding, remove weld splatter, flux, slag, and burrs left by attachments.
3. Welds shall be repaired in order to produce a workmanlike appearance, with uniform weld contours and dimensions.
4. Sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

3.3 GALVANIZING

1. Structural steel plates shapes, bars, and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A 123.
2. Any galvanized part that becomes warped during the galvanizing operation shall be straightened.
3. Bolts, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A153.

4. Field Repairs

- a) Field repairs to damaged galvanizing shall be performed by preparing the surface and applying a coating.
- b) Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush-off blast cleaning (SSPC SP7) over an area extending at least 4 inches into the undamaged area.
- c) The coating shall be applied to at least 3 mils dry film thickness, and shall be **Zinc-Clad XI** by **Sherwin-Williams**, **Galvax** by **Alvin Products**, **Galvite** by **ZRC Worldwide**, or equal.

3.4 DRILLED ANCHORS

1. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions.
2. Holes shall be roughened with a brush on a power drill, and then cleaned and dried.

3. Drilled anchors shall not be installed until the concrete has reached the required 28-day compressive strength.
4. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

- END OF SECTION -

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SECTION 31 11 00 - SITE PREPARATION

PART 1 -- GENERAL

1.1 SUMMARY

- A. In the initial move onto the Site, the CONTRACTOR shall protect existing fences, houses and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees, or other objects dislodged during the construction process and clear, grub, strip; and regrade certain areas, in accordance with the Contract Documents.

1.2 SITE INSPECTION

- A. Prior to moving onto the Site, the CONTRACTOR shall inspect the Site conditions and review maps of the Site and off-Site pipeline routes and facilities delineating the OWNER's property and right-of-way lines.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 PRIMARY SITE ACCESS

- A. The CONTRACTOR shall develop any necessary access to the Site, including access barriers to prohibit entry of unauthorized persons.
- B. **Utility Interference:** Where existing utilities interfere with the WORK, notify the utility owner and the ENGINEER before proceeding in accordance with the General Conditions.

3.2 CLEARING, GRUBBING, AND STRIPPING

- A. Construction areas shall be cleared of grass, weeds, and shrubs or trees to at least a depth of 6-inches and cleared of structures, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the WORK, create a hazard to safety, or impair the subsequent usefulness of the WORK, or obstruct its operation. Loose boulders within 10-feet of the top of cut lines shall be incorporated in landscaping or removed from the Site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction.
- B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove stumps, roots, buried logs, and other objectionable material. Septic tanks, drain fields, and connection lines and any other underground structures, debris or waste shall be removed if found on the Site. Objectionable material from the clearing and grubbing process shall be removed from the Site and wasted in approved safe locations.

- C. The entire area to be affected by construction shall be stripped to a depth of 1.5-feet below the existing ground contours. The stripped materials shall be stockpiled and incorporated into landscaped areas or other non-structural embankments.
- D. Unless otherwise indicated, native trees larger than 3-inches in diameter at the base shall not be removed without the ENGINEER's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if necessary for the CONTRACTOR's choice of means and methods, shall be arranged with the owner of the property, and shall be removed and replaced, as part of the WORK.
- E. Shrubs cleared from the WORK area shall be mulched on-site and spread evenly over topsoil to promote revegetation of disturbed areas. Excess mulch shall be cast or spread across the property at the landowner's discretion.

3.3 OVEREXCAVATION, REGRADING, AND BACKFILL UNDER FILL AREAS

- A. After the fill areas have been cleared, grubbed, and excavated, the areas to receive fill will require overexcavation, regrading, and backfill, consisting of the removal and/or stockpiling of undesirable soils. The ground surface shall be recontoured for keying the fill and removing severe or abrupt changes in the topography of the Site. The overexcavated volumes to a level 1.0-feet below the existing ground contours shall be backfilled.
- B. Any undesirable topsoil and colluvium shall be removed to the level designated by the ENGINEER and stockpiled for subsequent use as the first material to be placed in the compacted fill.
- C. Any steep, very abrupt rock faces and irregularly shaped rock outcrops of bedrock shall be regraded as directed by the ENGINEER.

- END OF SECTION -

SECTION 31 23 19 - DEWATERING

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall dewater trench and structure excavations, in accordance with the Contract Documents. The CONTRACTOR shall secure all necessary permits to complete the requirements of this Section of the Specifications.

1.2 CONTRACTOR SUBMITTALS

- A. Prior to commencement of excavation, the CONTRACTOR shall submit a detailed plan and operation schedule for dewatering of excavations. The CONTRACTOR may be required to demonstrate the system proposed and to verify that adequate equipment, personnel, and materials are provided to dewater the excavations at all locations and times. The CONTRACTOR's dewatering plan is subject to review by the ENGINEER.

1.3 QUALITY CONTROL

- A. It shall be the sole responsibility of the CONTRACTOR to control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.
- B. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the CONTRACTOR.
- C. Where critical structures or facilities exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the CONTRACTOR. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the CONTRACTOR.

PART 2 -- PRODUCTS

2.1 EQUIPMENT

- A. Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the Site.

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

- A. The CONTRACTOR shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all

times to insure efficient dewatering and maintenance of dewatering operation during power failure.

- B. Dewatering for structures and pipelines shall commence when surface water or groundwater is first encountered, and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.
- C. At all times, site grading shall promote drainage. Surface runoff shall be diverted from excavations. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.
- D. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.
- E. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.
- F. The CONTRACTOR shall maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.
- G. Flotation shall be prevented by the CONTRACTOR by maintaining a positive and continuous removal of water. The CONTRACTOR shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.
- H. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface.
- I. The CONTRACTOR shall dispose of water from the WORK in a suitable manner without damage to adjacent property. CONTRACTOR shall be responsible for obtaining any permits that may be necessary to dispose of water. No water shall be drained into work built or under construction without prior consent of the ENGINEER. Water shall be filtered using an approved method to remove sand and fine-sized soil particles before disposal into any drainage system. Discharge from any dewatering system to a waterway shall meet the most stringent of local, State, or Federal requirements.
- J. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the WORK and all costs thereof shall be included in the various contract prices in the Bid Forms, unless a separate bid item has been established for dewatering.

- END OF SECTION -

SECTION 31 30 00 - EARTHWORK

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall perform earthwork as indicated and required for construction of the WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit certification of material gradations and proposed for the WORK in conformance with the requirements of Section 01 33 00 – Contractor Submittals. Sample sizes shall be as determined by the testing laboratory.

- B. CONTRACTOR's Detailed Excavation Plan

1. The CONTRACTOR, prior to beginning any trench or structure excavation 5 feet deep or deeper, shall submit to the OWNER and shall be in receipt of the OWNER's written acceptance of the CONTRACTOR's detailed plan showing the design of shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation.
2. The CONTRACTOR's plan shall be prepared and signed and sealed by a Professional Engineer experienced in the field of geotechnical engineering and licensed in the State where the WORK is being performed.
3. The OWNER's acceptance of said plan will be for verification of submittal of the plan with this requirement.

PART 2 -- PRODUCTS

2.1 FILL AND BACKFILL MATERIAL REQUIREMENTS

- A. **General**

1. Fill, backfill, and embankment materials shall be selected or shall be processed and clean fine earth, rock, gravel, or sand, free from grass, roots, brush, other vegetation and organic matter.
2. Fill and backfill materials that are to be placed within 6 inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3 inches.

- B. **Suitable Materials**

1. Materials not defined below as unsuitable will be considered as suitable materials and may be used in fills, backfilling, and embankment construction, subject to the indicated requirements.

2. If acceptable to the ENGINEER, some of the material listed as unsuitable may be used when thoroughly mixed with suitable material to form a stable composite.
3. Mixing or blending of materials to obtain a suitable composite is the CONTRACTOR's option but is subject to the approval of the ENGINEER.
4. Suitable materials may be obtained from on-Site excavations, may be processed on-Site materials, or may be imported.
5. If imported materials are required by this Section or are required in order to meet the quantity requirements of the WORK, the CONTRACTOR shall provide the imported materials as part of the WORK.

C. **Types of Suitable Materials.** The following types of suitable materials are defined:

Type AS (Aggregate Subbase): Crushed rock aggregate subbase material that can be compacted readily by watering and rolling to form a firm stable base. This material is often specified and required underneath the base course of asphaltic or concrete pavement. At the option of the CONTRACTOR, the grading for either the 3-inch maximum size or 2-inch maximum size gradation shall be used. The sand equivalent value shall be greater than 20. Crushed rock aggregate subbase material shall meet one of the following gradation requirements, as shown on the Drawings or approved by the OWNER:

Sieve Size	Percentage Passing (3-inch Max)	Percentage Passing (2-inch Max)
3-inch	100	100
2.0 inch	90 - 100	100
1.5 inch	-	95 - 100
No. 4	30 - 65	30 - 65
No. 16	15 - 40	15 - 40
No. 200	0 - 20	0 - 20

Type C (Civil Fill) (Not for use beneath concrete foundations): Civil Fill may consist of imported materials or natural on-site materials. Civil Fill may be a combination of Type AS material, Type GF, or Type SF material, or any mixture thereof, except as shown. Some mixing, removal of oversized particles (greater than 4-inch diameter) and/or removal of other unsuitable material may be required.

Type DRG (Drain-rock Graded): Drain-rock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The drainrock shall have a sand equivalent value greater than 75. The finish graded surface of the drainrock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs. The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
3/4-inch	90 – 100
3/8-inch	40 – 100
No. 4	25 – 40
No. 8	18 – 33
No. 30	5 – 15
No. 50	0 – 7
No. 200	0 – 3

As an alternative to the above gradation, the CONTRACTOR may use the approved State of Idaho Department of Transportation’s **IDOT’s** – Class 1, 2a, or 2b Coarse Aggregate material.

Type EF (Embankment Fills from on-site materials): Embankment Fill for the general fill and grading portions of the project may be obtained from on-Site excavations, may be processed on-Site materials, or may be imported materials comprised of mixtures of Type AS, Type DRG, Type GF, or Type S material. If on-site material is used for embankments, it may require moisture conditioning to facilitate compaction. Drying of the embankment fill material may not be practical during cold or wet periods of the year. Acceptable embankment material shall meet or exceed the compaction density of 95 percent as determined by ASTM D-1557.

Type GF (Granular Fill 3/4-inch minus): Angular crushed rock, stone or gravel, and sand conforming to the requirements listed below. Do not use pea gravel as granular backfill: The material shall have a maximum liquid limit of 35 and a maximum plasticity index of 10. The material shall have a sand equivalent value greater than 75. (This material is also known as Class I crushed stone.)

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	30 - 50
No. 200	0 - 6

As an alternative to the above gradation, the CONTRACTOR may use the approved State of Idaho Department of Transportation's **IDOT's** – Class 3/4A Aggregate for Untreated Base.

Type SF (Structural Fill / Foundation Base): Crushed rock structural fill material of such nature that it can be compacted readily by watering and rolling to form a firm, stable base for fill material required beneath concrete foundations. This material is often specified and required directly underneath the finish course of asphaltic or concrete pavement. At the option of the CONTRACTOR, the grading for either the 1-1/2 inch maximum size or 3/4-inch maximum size gradation may be used material beneath concrete foundations. The sand equivalent value shall be greater than 22. The material shall meet the following gradation requirements:

Sieve Size	Percentage Passing	
	1-1/2 inch Max Gradation	3/4-inch Max Gradation
2-inch	100	-
1-1/2-inch	90 - 100	-
1-inch	-	100
3/4-inch	81 - 91	90 – 100
No. 4	43 - 53	55 – 67
No. 16	23 - 29	28 – 38
No. 200	4 - 10	4 – 10

Type T (Topsoil): Stockpiled topsoil material which has been obtained at the Site by removing soil to a depth not exceeding 2 feet. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.

Schedule: Earth materials shall be as indicated in the Contract Drawings. Where clear definition in the drawings is not defined, the following schedule may be used to define acceptable fill materials.

Work Area	Material Type
Embankment Fills – Intake Structure Berms	Type EF material
Pipe Zone (unless indicated as Trench Zone)	
Other PVC, VCP, HDPE Pipe	GF
Trench zone backfill except as identified below	C, EF or an approved mixture thereof.
Final backfill for irrigated unpaved areas	T
Trench zone and final backfill under structures	Same as pipe zone except where concrete encasement is required
Gravel Road base materials	GF
Gravel Road subbase materials	AS or approved native sand-gravel-cobble mix.
Backfill around structures (including berms)	C, EF, SF or an approved mixture
Under hydraulic or water retaining structures with underdrains	DRG
Under structures where ground water is removed to allow placement of concrete	DRG, underlain by non-woven filter fabric
All other structures	SF or approved native sand-gravel mix.
Top 6-inches embankment fills, or backfills around structures	T

D. Unsuitable Materials.

1. Soils which, when classified under ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System), fall in the classifications of PT, OH, CH, MH, or OL shall be classified as unsuitable materials.
2. In addition to the materials identified as unsuitable in the table above, a material shall be classified as unsuitable if one of the following conditions is present;

- a. Soils which cannot be compacted sufficiently to achieve the density specified for the intended use.
- b. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.

2.2 MATERIALS TESTING

A. Samples

1. Soils testing of samples submitted by the CONTRACTOR will be performed by a testing laboratory of the OWNER's choice and at the CONTRACTOR's expense.
2. The ENGINEER may direct the CONTRACTOR to supply samples for testing of any material used in the WORK.

B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils.

C. Determination of sand equivalent value will be performed using ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

D. Unified Soil Classification System

1. References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487.
2. The CONTRACTOR shall be bound by applicable provisions of ASTM D 2487 in the interpretation of soil classifications.

E. Testing for chloride shall be performed in accordance with AASHTO T291-94 – Standard Method of Test for determining Water-Soluble Chloride Ion Content in Soil.

2.3 IDENTIFICATION TAPE

A. Unless otherwise indicated, identification tape shall be placed above buried pipelines that are not comprised of magnetic components at least in part.

B. Identification tape shall be 6-inches wide, yellow in color, composed of polyethylene, and provided with an integral metallic wire.

C. Tape shall be labeled with CAUTION – BURIED UTILITIES.

PART 3 -- EXECUTION

3.1 EXCAVATION AND BACKFILLING - GENERAL

A. General

1. Except when specifically provided to the contrary, excavation shall include the removal of materials, including obstructions, that would interfere with the proper execution and completion of the WORK.
2. The removal of such materials shall conform to the lines and grades indicated or ordered.
3. Unless otherwise indicated, the entire Site shall be stripped of vegetation and debris and shall be grubbed, and such material shall be removed from the Site prior to performing any excavation or placing any fill.
4. The CONTRACTOR shall furnish, place, and maintain supports and shoring that may be required for the sides of excavations.
5. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable state safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).
6. The CONTRACTOR shall provide quantity surveys where so required to verify quantities for Unit Price Contracts.
7. Surveys shall be performed prior to beginning WORK and upon completion by a surveyor licensed in the state where the Site is located.

B. Removal and Exclusion of Water

1. The CONTRACTOR shall remove and exclude water, including stormwater, groundwater, and surface water from excavations.
2. Dewatering wells, wellpoints, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least 2 feet below the bottom of excavations before the excavation WORK begins at each location.
3. Water shall be removed and excluded until backfilling is complete and field soils testing has been completed.

3.2 OVER-EXCAVATION

A. Indicated

1. Where areas are indicated to be over-excavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade indicated.

B. Not Indicated

1. When ordered to over-excavate areas deeper and/or wider than required by the Contract Documents, the CONTRACTOR shall over-excavate to the dimensions ordered and backfill to the indicated grade.

C. Neither Indicated nor Ordered

1. Any over-excavation carried below the grade that is neither ordered or nor indicated shall be backfilled and compacted to the required grade with the indicated material as part of the WORK

3.3 EXCAVATION IN LAWN AREAS

- A. Where excavation occurs in lawn areas, the area disturbed by excavation, stockpiling, or vehicle traffic shall be reseeded in accordance with Specification 31 35 28.
- B. Excavated material may be placed on the lawn, provided that a drop cloth or other suitable method is employed to protect the lawn from damage, but the lawn shall not remain covered for more than 72 hours.

3.4 EXCAVATION IN VICINITY OF TREES

- A. Except where trees are indicated to be removed, trees shall be protected from injury during construction operations.
- B. Trees shall be supported during excavation by any means previously reviewed and accepted by the ENGINEER.

3.5 ROCK EXCAVATION

- A. Rock excavation shall include removal and disposal of the following items:
 1. Rock material in ledges, bedding deposits, and un-stratified masses that cannot be removed using conventional equipment as defined herein and which require systematic drilling and blasting for removal;
 2. Concrete or masonry structures that have been abandoned; and,
 3. Conglomerate deposits that are so firmly cemented that they possess the characteristics of solid rock and cannot be removed using conventional equipment as herein defined and require systematic drilling and blasting for removal.
- B. Scope and Payment
 1. Rock excavation shall be performed by the CONTRACTOR, provided that if the quantity of rock excavation is affected by any change in the scope of the WORK an appropriate adjustment of the Contract Price will be made. Payment for rock excavation shall be as set forth in the Bid form as a unit price item. If a unit price item for rock excavation is not provided in the Bid form, the extra cost for excavation of rock will be treated as a change.
 2. Otherwise, payment will be made in accordance with a negotiated price.

- C. Explosives and Blasting: Blasting will not be permitted.

3.6 DISPOSAL OF EXCESS EXCAVATED MATERIAL

- A. Unless otherwise indicated, excess excavated material shall be the property of the CONTRACTOR.

- B. The CONTRACTOR shall be responsible for the removal and disposal of excess excavated material.
- C. The CONTRACTOR shall remove and dispose of excess excavated material at a location selected by the CONTRACTOR and as approved by the ENGINEER or at an off-Site location selected and arranged for by the CONTRACTOR.
- D. The CONTRACTOR shall obtain required permits and landowner and agency approvals for disposal of excess excavated material on-Site or off-Site and shall submit copies of related documents to the ENGINEER for information prior to disposal. CONTRACTOR shall pay costs associated with the removal and disposal

3.7 BACKFILL

A. General

- 1. Backfill shall not be dropped directly upon any structure or pipe.
- 2. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed.
- 3. Backfill around water-retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.

- B. Except for drain rock materials being placed in over-excavated areas or trenches, backfill shall be placed after water is removed from the excavation and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. Pre-Placement Conditions

- 1. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have any loose, sloughing, or caving soil and rock materials removed.
- 2. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

D. Layering

- 1. Backfill materials shall be placed and spread evenly in layers.
- 2. When compaction is achieved using mechanical equipment, the layers shall be evenly spread such that when compacted each layer shall not exceed 6 inches in thickness.

- E. During spreading, each layer shall be thoroughly mixed as necessary in order to promote uniformity of material in each layer.

F. Moisture Content

1. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.
2. Where the backfill material moisture content is too high to permit the indicated degree of compaction, the material shall be dried until the moisture content is satisfactory.

3.8 STRUCTURE AND EMBANKMENT EXCAVATION AND BACKFILL

A. Excavation Beneath Structures and Embankments

1. Except where indicated otherwise for a particular structure or where ordered by the ENGINEER, excavation shall be carried to an elevation 1 foot below the bottom of the footing or slab and brought back to grade with compacted materials acceptable for placement beneath structures.
2. The area where a fill or embankment is to be constructed shall be cleared of vegetation, roots, and foreign material.
3. Where indicated or ordered, areas beneath structures or fills shall be over-excavated.
4. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched.
5. When such over-excavation is indicated, both the over-excavation and the subsequent backfill to the required grade shall be performed by the CONTRACTOR.
6. After the required excavation or over-excavation for fills and embankments has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

B. Compaction of Fill, Backfill, and Embankment Materials

1. Each layer of backfill materials as defined herein, where the material is graded such that 10 percent or more passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density.
2. Equipment that is consistently capable of achieving the required degree of compaction shall be used, and each layer shall be compacted over its entire area while the material is at the required moisture content.
3. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of obtaining the required density in 2 passes.

- C. Flooding, ponding, and jetting shall not be used for fill on backfill around structures, for final backfill materials, or aggregate base materials.

D. Heavy Equipment

1. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the vertical depth of the fill above undisturbed soil at that time.
2. Hand-operated power compaction equipment shall be used where the use of heavier equipment is impractical or restricted due to weight limitations.

E. Layering

1. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers.
2. Each layer shall be moistened and aerated as necessary.
3. Unless otherwise approved by the ENGINEER, no layer shall exceed 6 inches of compacted thickness.
4. The embankment and fill shall be compacted in conformance with Paragraph K, below.

F. Embankments and Fills

1. When an embankment or fill is to be constructed and compacted against hillsides or fill slopes steeper than 4:1, the slopes of the hillsides or fills shall be horizontally benched in order to key the embankment or fill to the underlying ground.
2. A minimum of twelve (12) inches perpendicular to the slope of the hillside or fill shall be removed and re-compacted as the embankment or fill is brought up in layers.
3. Material thus cut shall be re-compacted along with the new material.
4. Hillside or fill slopes 4:1 or flatter shall be prepared in accordance with Paragraph A, above.

G. Compaction Requirements

1. The following compaction requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft³) (2,700 kN-m/m³) where the material is graded such that ten (10) percent or more passes a No. 4 sieve and in accordance with ASTM D 4253 - Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density, where the material is coarse granular backfill materials with less than ten (10) percent passing the No. 4 sieve:

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density	Percentage of Relative Density
Embankments and fills not identified otherwise	90	55
Embankments and fills beneath paved areas or structures	95	70
Backfill beneath structures and hydraulic structures	95	70
Topsoil	80	NA
Aggregate base or subbase	95	NA

3.9 PIPELINE AND UTILITY TRENCH EXCAVATION AND BACKFILL

A. Exploratory Excavations

1. The CONTRACTOR shall excavate and expose buried points to existing utilities as indicated.
2. Damage to utilities from excavation activities shall be repaired by the CONTRACTOR in accordance with the General Conditions.

B. General

1. Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with minimum widths as indicated.

C. Trench Bottom

1. Except where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe.
2. Excavations for pipe bells and welding shall be made as required.
3. Where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe bedding.

D. Open Trenches

1. The maximum amount of open trench permitted in any one location shall be 500 feet or the length necessary to accommodate the amount of pipe installed in a single Day, whichever is greater.
2. Trenches shall be fully backfilled at the end of each Day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each Day.
3. These requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 50 feet from any traveled roadway or occupied structure; in such cases, however, barricades and warning lights meeting appropriate safety requirements shall be provided and maintained.

E. Embankments, Fills and Structural Backfills

1. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.
2. Upon completion of the embankment or structural backfill, a trench conforming to the appropriate detail may be excavated and the pipe may be installed.

F. Trench Shield

1. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield such that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls and causing sloughing or caving of the trench walls.
2. If the trench walls cave or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.
3. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally.
4. The CONTRACTOR shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

G. Placing and Spreading Of Backfill Materials

1. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of achieving the required density in 2 passes and that is acceptable to the ENGINEER.
2. Where such materials are used for pipe zone backfill, vibratory compaction shall be used at vertical intervals of the lesser of:

- a. one-half the diameter of the pipe; or
 - b. 24 inches, measured in the uncompacted state.
3. In addition, these materials shall be subjected to vibratory compaction at the springline of the pipe and the top of the pipe zone backfill, regardless of whether that dimension is less than 24 inches or not.
 4. Each layer of backfill material with greater than 10 percent passing the No. 4 sieve shall be compacted using mechanical compactors suitable for the WORK.
 5. The material shall be placed and compacted under the haunch of the pipe and up each side evenly so as not to move the pipe during the placement of the backfill.
 6. The material shall be placed in lifts that will not exceed 6 inches when compacted to the required density.

H. Mechanical Compaction

1. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand-operated vibratory compactors and rollers that do not damage the pipe.
2. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

I. Pipe And Utility Trench Backfill

1. Pipe Zone Backfill

a. Definitions

- 1) The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane below the bottom surface of the pipe and a plane at a point above the top surface of the pipe as indicated.
- 2) The bedding is defined as that portion of pipe zone backfill material between the trench subgrade and the bottom of the pipe.
- 3) The embedment is defined as that portion of the pipe zone backfill material between the bedding and a level line as indicated.

b. Final Trim

- 1) After compacting the bedding, the CONTRACTOR shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe.
- 2) Excavation for pipe bells and welding shall be made as required.

- c. The pipe zone shall be backfilled with the indicated backfill material.
- d. Pipe zone backfill materials shall be manually spread evenly around the pipe, maintaining the same height on both sides of the pipe such that when compacted the pipe zone backfill will provide uniform bearing and side support.
- e. The CONTRACTOR shall exercise care in order to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.

2. Trench Zone Backfill

- a. After the pipe zone backfill has been placed, backfilling of the trench zone may proceed.
- b. The trench zone is defined as that portion of the vertical trench cross-section lying as indicated between a plane above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.

3. Final Backfill

- a. Final backfill is defined as backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under pavement, backfill within 18 inches of the roadway subgrade.

J. Trench Shield

- 1. If a moveable trench shield is used during backfill operations, the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer.
- 2. The CONTRACTOR shall not displace the pipe or backfill while the shield is being moved.

K. Compaction Requirements

- 1. The following compaction test requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft³) (2,700 kN-m/m³) where the material is graded such that 10 percent or more passes a No. 4 sieve, and in accordance with ASTM D 4253 - Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve.

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density	Percentage of Relative Density
Pipe embedment backfill for	95	70

flexible pipe.		
Pipe bedding and over-excavated zones under bedding for flexible pipe, including trench plugs.	95	70
Pipe embedment backfill for steel yard piping	---	70
Pipe zone backfill portion above embedment for flexible pipe	95	70
Final backfill, beneath paved areas or structures.	95	70
Final backfill, not beneath paved areas or structures.	90	55
Trench zone backfill, beneath paved areas and structures, including trench plugs.	95	70
Trench zone backfill, not beneath paved areas or structures, including trench plugs.	90	55

3.10 FIELD TESTING

A. General:

1. Field soils testing will be performed by a testing laboratory of the OWNER's choice at the OWNER's expense, except as indicated below.

B. Density

1. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557.
2. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 7382.
3. Field density in-place tests will be performed in accordance with ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth), or by such other means acceptable to the ENGINEER.

C. Remediation

1. In case the test of the fill or backfill shows non-compliance with the required density, the CONTRACTOR shall accomplish such remedy as may be required to ensure compliance.
2. Subsequent testing to show compliance shall be by a testing laboratory selected by the OWNER and paid by the CONTRACTOR.

D. CONTRACTOR's Responsibilities

1. The CONTRACTOR shall provide test trenches and excavations, including excavation, trench support and groundwater removal for the OWNER's field soils testing operations.
2. The trenches and excavations shall be provided at the locations and to the depths as required by the OWNER.
3. Lawn areas destroyed by test trenching and excavation shall be regraded and relandscaped with hydroseeding.

- END OF SECTION -

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SECTION 31 35 26 - EROSION CONTROL BARRIER

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide erosion control barriers, complete and in place, in accordance with the Contract Documents

1.2 CONTRACTOR SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00 - Contractor Submittals.
- B. **Product Data:** Manufacturer's catalog sheets on geotextile fabrics.

PART 2 -- PRODUCTS

2.1 FABRIC

- A. Fabric may be woven or non-woven, made from polypropylene, polyethylene, or polyamid, and shall contain sufficient UV inhibitors so that it will last for 2 years in outdoor exposure.
- B. Fabric shall have the following properties:

Parameter	Standard Method	Value
Grab tensile strength	ASTM D 4632	100 lb
Burst strength	ASTM D 3786	200 psi
Apparent opening size	ASTM D 4751	Between 200 and 70 sieve size

- C. Fabric Manufacturer, or equal

- 1. **Mirafi**

2.2 POSTS

- A. Posts shall be wood, at least 2 inches by 2 inches, at least 6 feet long.

2.3 FENCING

- A. Woven wire fabric fencing shall be galvanized, mesh spacing of 6 inches, maximum 14-gauge, at least 30 inches tall.

2.4 FASTENERS

- A. Fasteners to wood posts shall be steel, at least 1 1/2 inches long.

- B. Fasteners to steel posts shall be galvanized clips.

PART 3 -- EXECUTION

3.1 PREPARATION

- A. Provide erosion control barriers at the indicated locations and as required to prevent erosion and silt loss from the Site.
- B. CONTRACTOR shall not commence clearing, grubbing, earthwork, or other activities which may cause erosion until barriers are in place.

3.2 INSTALLATION

- A. Barrier systems shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.
- B. Attach the woven wire fencing to the posts that are spaced a maximum of 6 feet apart and embedded a minimum of 12 inches. Install posts at a slight angle toward the source of the anticipated runoff.
- C. Trench in the toe of the filter fabric barrier with a spade or mechanical trencher so that the downward face of the trench is flat and perpendicular to the direction of flow. Lay fabric along the edges of the trench. Backfill and compact.
- D. Securely fasten the fabric materials to the woven wire fencing with tie wires.
- E. Reinforced fabric barrier shall have a height of 18 inches.
- F. Provide the filter fabric in continuous rolls and cut to the length of the fence to minimize the use of joints. When joints are necessary, splice the fabric together only at a support post with a minimum 6-inch overlap and seal securely.

3.3 MAINTENANCE

- A. Regularly inspect and repair or replace damaged components of the barrier. Unless otherwise directed, maintain the erosion control system until final acceptance; then remove erosion and sediment control systems promptly.
- B. Remove sediment deposits when silt reaches a depth of 6 inches or 1/2 the height of the barrier, whichever is less. Dispose of sediments on the Site, if a location is indicated on the Drawings, or at a site arranged by the CONTRACTOR which is not in or adjacent to a stream or floodplain.

- END OF SECTION -

SECTION 31 35 28 - EROSION CONTROL (VEGETATIVE)

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide erosion protection including fertilizing, seeding, and mulching for all disturbed areas that are not to be paved or otherwise treated in accordance with the Contract Documents.

PART 2 -- PRODUCTS

2.1 MATERIALS

- A. **Seed:** Seed shall be delivered in original unopened packages bearing an analysis of the contents that clearly states Certified Seed (Blue tag), Registered Seed (purple tag), or Foundation Seed (white tag). Seed shall be guaranteed 95 percent pure with a minimum germination rate of 80 percent.

- 1. Seed mix shall be:

COMMON NAME	SPECIES	% MIX	SEEDS/SQ.FT	PLS LBS/AC
SLENDER WHEATGRASS PRYOR	ELYMUS TRACHYCAULUS SSP. TRACHYCAULUS	25.0	10	3.23
MOUNTAIN BROME	BROMUS MARGINATUS	40.0	16	8.71
BIG BLUEGRASS	POA SECUNDA	5.0	2	0.10
TRITICALE QUICKGUARD	TRITICUM ASETIVUM X SECALE CEREALE	4.0	1.6	5.35
IDAHO FESCUE	FESTUCA IDAHOENSIS	22.0	8.8	0.85
BLUE FLAX APPAR	LINUUM PERENNE	2.0	0.8	0.12
COMMON YARROW	ACHILLEA MILLEFOLIUM	2.0	0.8	0.01
TOTAL		100%	40	18.37

- B. **Mulch:** Mulch shall be a fibrous, wood cellulose product produced for this purpose. It shall be dyed green and shall contain no growth or germination inhibiting substances and shall be manufactured so that when thoroughly mixed with seed, fertilizer, and water, in the proportions indicated it will form a homogenous slurry which is capable of being sprayed. The mulch shall be **Silva Fiber** as manufactured by **Weyerhaeuser Company**; **Conwood Fiber** as manufactured by **Consolidated Wood Conversion Corp.**; or equal.
- C. **Native Mulch:** Woody vegetation removed during clearing and grubbing shall be mulched and cast across revegetation areas. Depth of mulch shall not inhibit growth of grass seed.

PART 3 -- EXECUTION

3.1 GENERAL

- A. **Weather Conditions:** Fertilizing, seeding, or mulching operations will not be permitted when wind velocities exceed 15 miles per hour or when the ground is frozen, unduly wet, or otherwise not in a tillable condition.
- B. **Soil Preparation:** The ground to be seeded shall be graded in conformance with the Drawings and shall be loose and reasonably free of large rocks, roots, and other material which will interfere with the work.
- C. **Method of Application:** Fertilizer, seed, and mulch may be applied separately (Dry Method), or they may be mixed together with water and the homogeneous slurry applied by spraying (Hydraulic Method), except that all slopes steeper than 3 units horizontal to 1 unit vertical shall be stabilized by the Hydraulic Method.

3.2 DRY METHOD

- A. **Seeding:** The seed shall be broadcast uniformly at the rate of 18.4 lbs/acre. After the seed has been distributed it shall be incorporated into the soil by raking or by other approved methods. Seed shall be installed between mid-October and mid to late November. If required by the Project schedule, seeding may occur in the spring upon the end of snowmelt period. However, fall seeding is preferred.
- B. **Mulch Application:** Mulch shall be applied such that approximately 25% of bare soil can be observed and mulch depth is no more than 1 to 2 inches thick.

3.3 EROSION CONTROL BLANKET

A. Placement

- 1. Biodegradable erosion control blanket shall be used on all slopes [4H:1V] and steeper.
- 2. The erosion control shall be spread only on prepared, fertilized and seeded surfaces.
- 3. On all slopes, the erosion control blanket shall be laid up-and-down the slope in the direction of water flow.
- 4. Waste of erosion control material shall be minimized by limiting overlaps as specified and by utilizing the full length of the netting at roll ends.

B. Anchorage

- 1. Ends and sides of adjoining pieces of material shall be overlapped 6-inches and 4-inches respectively, and stapled or held with anchored with native material such as boulders or logs. Six anchors shall be installed across ends. A common row of staples shall be used at side joints. Staple through both blankets, placing staples approximately 6-inches apart. Staples shall be biodegradable.

2. The top edge of the erosion control blanket shall be anchored in a 6-inch deep by 6-inch wide trench. Backfill and compact trench after stapling.
3. Anchorage shall be by means of 9-inch long, 2-legged staples driven vertically and full-length into the ground. The legs shall be spread 3-inches to 4-inches apart at the ground to improve resistance to pull-out.
4. All slopes which are 3:1 or greater shall be stapled with 2 staples per square yard in a triangular pattern. Staples shall be installed per the manufacturer's recommended staple pattern guide.
5. The erosion control blanket shall not be stretched, but should be laid loosely over the ground to avoid pulling the blanket downslope.
6. The erosion control blanket shall not be rolled out onto ground containing frost within the 9-inch penetration zone of the anchorage staples. Further, no stapling shall be undertaken while any frost exists within the staple penetration zone.

3.4 MAINTENANCE PRIOR TO FINAL ACCEPTANCE

- A. The CONTRACTOR shall maintain the planted areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include the filling, leveling, and repairing of any washed or eroded areas, as may be necessary, and sufficient watering to maintain the plant materials in a healthy condition. The ENGINEER may require replanting of any areas in which the establishment of the vegetative ground cover does not appear to be developing satisfactorily.

- END OF SECTION -

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SECTION 31 37 00 - RIPRAP

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide riprap, including associated earthwork, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM C 88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 535	Standard Test Method for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
AASHTO T 85	Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate
AASHTO T 210	Method of Test for Aggregate Durability Index.

1.3 CONTRACTOR SUBMITTAL

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

PART 2 -- PRODUCT

2.1 STONES FOR RIPRAP

- A. Stones shall be graded in size to produce a reasonably dense mass. Riprap shall consist of dense, natural rock fragments. Stones shall be resistant to weathering and to water action; free from overburden, spoil, shale, and organic material; and shall meet the gradation requirements below. Shale and stones with shale seams are not acceptable.

- B. Riprap shall conform to the size types as follows:

1. Type I (6-inch Average Size):

Diameter	Percentage Passing
12-inch	95 - 100
6-inch	25 - 75
3-inch	0 - 10

2. Type II (12-inch Average Size):

Diameter	Percentage Passing
18-inch	95 - 100
12-inch	25 - 75
6-inch	0 - 5

3. Type III (18-inch Average Size):

Diameter	Percentage Passing
24-inch	95 - 100
18-inch	25 - 75
13-inch	0 - 5

4. Type IV (24-inch Average Size):

Diameter	Percentage Passing
30-inch	95 - 100
24-inch	25 - 75
18-inch	15 - 25
12-inch	0 - 5

- C. When readily available, CONTRACTOR may utilize native cobbles and boulders for riprap applications. Native cobbles and boulders shall meet or exceed the dimensions of the riprap gradations specified in the drawings. Where roundness of native boulders may result in embankment stability (i.e. rolling) issues, CONTRACTOR shall notify the ENGINEER to determine if angular riprap or reduction in embankment slope is required.
- D. The greatest dimension of 50 percent of the stones shall be at least two-thirds but not more than 1-1/2 times the diameter of the average size. Neither the breadth nor thickness of any piece of riprap shall be less than one-third its length. Material shall be of shapes which will form a stable protection structure of required depth. Rounded boulders or cobbles shall not be used.
- E. Stones shall consist of durable, sound, hard, angular rock meeting the following requirements for durability absorption ratio, soundness test, and abrasion test:

Durability Absorption Ratio	Acceptability
Greater than 23	Passes
10 to 23	Passes only if Durability Index is 52 or greater
Less than 10	Fails
Durability Absorption Ratio	<u>Durability Index (Coarse)</u> % absorption + 1

- F. The durability index and percent absorption shall be determined by AASHTO T 210 and AASHTO T 85, respectively. The minimum apparent specific gravity of the stones shall be 2.5 as determined by AASHTO T 85.
- G. Stones shall have less than 10 percent loss of weight after five cycles, when tested per ASTM C 88.
- H. Stones shall have a wear not greater than 40 percent, when tested per ASTM C 535.
- I. Control of gradation shall be by visual inspection. The CONTRACTOR shall furnish a sample of the proposed gradation of at least 5 tons or 10 percent of the total riprap weight, whichever is less. If approved, the sample may be incorporated into the finished riprap at a location where it can be used as a frequent reference for judging the gradation of the remainder of riprap.
- J. The acceptability of the stones will be determined by the ENGINEER prior to placement. Any difference of opinion between the ENGINEER and the CONTRACTOR shall be resolved by dumping and checking the gradation of two random truckloads of stones. Arranging for and the costs of mechanical equipment, a sorting site, and labor needed in checking gradation shall be the CONTRACTOR's responsibility.

2.2 STONES FOR ROCK VANES

- A. Stones for rock vanes shall be equal or greater in size to the rock diameters specified in the design documents. The rock shall consist of angular rock generally rectangular in shape and meet the durability requirements specified above. Rocks may not exceed 200% of the specified dimension along the longest axis. Rock dimensions shall follow the following shape requirements:

	A-Axis	B-Axis	C-Axis
Minimum Size	100%	75%	50%
Example: 36" Dia. Rock Dimensions	36"	27"	18"

2.3 GEOTEXTILE FABRIC

- A. Geotextile fabric shall conform to the requirements of Section 31 05 19 - Geotextiles.

2.4 FILTER MATERIAL

- A. Filter material shall be clean and free from organic matter. It shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformity graded and shall conform to the following gradation:

1. Type 1

Size	Percentage Passing
3-inch	85 – 100
1-1/2 inch	45 – 75
3/4-inch	10 – 25

2. Type 2

Size	Percentage Passing
2-inch	100
1-1/2 inch	90 – 100
3/4-inch	50 – 85
No. 4	25 – 45
No. 30	10 - 25
No. 200	2 - 9

PART 3 -- EXECUTION

3.1 SURFACE PREPARATION

- A. Surfaces to receive riprap shall be smooth and firm, free of brush, trees, stumps, and other objectionable material, and shall be brought to the line and grade indicated.
- B. If a boulder is encountered during excavation of areas where large riprap is to be placed, the CONTRACTOR shall excavate around the boulder. If the boulder is larger than the

largest allowable stone size for that area, the CONTRACTOR shall break up the boulder to an acceptable size or remove it entirely.

- C. Prior to placement of the geotextile, the surface shall be prepared to a smooth condition free of debris, depressions, or obstructions which may damage the geotextile. The geotextile shall be overlapped a minimum of 2-feet at longitudinal and transverse joints. Upstream sheets shall overlap downstream sheets. For slope placement, each strip shall overlap the next downhill strip. The geotextile shall be anchored using key trenches or aprons at the crest and toe of the slope. Pins may be used in securing the geotextile during installation. In no instance shall the geotextile be left exposed to sunlight longer than 7 Days. Overexposed geotextile shall be removed and replaced.

3.2 PLACEMENT OF FILTER BLANKET

- A. Area of riprap placement shall be excavated to the bottom of the filter blanket as indicated and in accordance with Section 31 00 00 – Earthwork. After the excavation has been completed, the top 12-inches of exposed surface shall be scarified, brought to optimum moisture content, and compacted to 95 percent of maximum density. The finished grade shall be even, self-draining, and in conformance with the slope of the finished grade.
- B. Placement of filter material shall be in accordance with Section 31 00 00. Filter material shall be placed, spread, and compacted in lifts not to exceed 12-inches.
- C. The CONTRACTOR shall remove any portion of the filter blanket that has been disturbed to the degree that the layers become mixed. Replace the removed portion with the required sizes.
- D. Filter material shall be placed as follows, unless otherwise indicated.
 - 1. For Type II, III and IV riprap, use 12-inches of Type 1 filter material.
 - 2. For Type I riprap, use 6-inches of Type 2 filter material.
- E. No filter material is required if riprap is placed directly on bedrock.]

3.3 PLACEMENT OF RIPRAP

- A. Placement of riprap shall begin at the toe of the slope and proceed up the slope. The stones may be placed by dumping and may be spread by bulldozers or other suitable equipment as long as the underlying material is not displaced. Stones shall be placed so as to provide a minimum of voids. Smaller stones shall be uniformly distributed throughout the mass. Sufficient hand work shall be done to produce a neat and uniform surface, true to the lines, grades, and sections indicated.
- B. Where riprap is placed over a geotextile fabric, the riprap shall be placed so as to avoid damage to the geotextile. Stones shall not be dropped from a height greater than 3-feet, nor shall large stones be allowed to roll downslope.

- END OF SECTION -

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**SECTION 33 11 22 - LARGE PVC PRESSURE PIPE, RUBBER JOINTS
(AWWA C905, MODIFIED)**

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide polyvinyl chloride (PVC) pressure pipe, complete in place, in accordance with the Contract Documents.
- B. **Pipe Material Group No. 19.** The piping system defined in this section is referred to in the Pipe Schedule on Contract Sheet G-005 as Piping Material Group No. 19.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

AWWA C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110	Ductile-Iron and Gray-Iron Fittings 3-in Through 48-in for Water
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
ASTM D 2584	Standard Test Method for Ignition Loss of Cured Reinforced Resins
AWWA C905	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14-in Through 48-in, for Water Transmission and Distribution
AWWA Manual M23	PVC Pipe - Design and Installation
PPI Technical Report TR 3/4	Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials

1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
- B. **Shop Drawings:** Drawings of pipe, fittings, and appurtenances. Calculations showing compliance with this Section. Manufacturer's literature on the metallic locating tape.
- C. **Certifications:** A certified affidavit of compliance for all pipe and other products or

materials furnished under this Section.

1. Hydrostatic proof test reports.
 2. Sustained pressure test reports.
 3. Burst strength test reports.
- D. The CONTRACTOR shall be responsible for performing and paying for sampling and testing as necessary for the certifications.

1.4 QUALITY CONTROL

- A. **Inspection:** Pipe shall be subject to inspection by the ENGINEER prior to install.
- B. **Tests:** Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with this Section and the referenced standards, as applicable.
- C. The CONTRACTOR shall perform said material tests. The ENGINEER shall have the right to witness testing; provided, that the CONTRACTOR'S schedule is not delayed for the convenience of the ENGINEER.
- D. In addition to those tests specifically required, the ENGINEER may request additional samples of any material for testing by the OWNER. The additional samples shall be furnished as part of the WORK .

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Large PVC pressure pipe (14-inch through 48-inch) shall conform to the applicable requirements of AWWA C905 and the additional requirements herein.

2.2 PIPE

- A. The pipe shall be of the diameter and pressure class indicated, shall be furnished complete with elastomeric gaskets, and specials and fittings shall be provided as required in the Contract Documents. The dimensions and pressure classes for large PVC pressure pipe with Cast-Iron Pipe Equivalent O.D.'s shall conform to Table 2 of AWWA C905.
- B. **Additives and Fillers:** Unless otherwise provided in alternate qualification procedures of PPI-TR3, compounds which have a Hydrostatic Design Basis (HDB) of 4000 psi at 73.4 degrees F for water shall not contain additives and fillers that exceed the recommended values in Table 1, Part Y of PPI-TR3 (e.g., allowable content range for calcium carbonate is 0.0-5.0 parts per hundred parts of resin). If requested by the ENGINEER, the additive and filler content shall be determined by using the pyrolysis method per ASTM D 2584.
- C. **Joints:** Joints for buried PVC pipe shall be either an integral bell manufactured on the pipe or a separate coupling both employing an elastomeric gasket. The bell and coupling

shall be the same thickness as the pipe barrel, or greater thickness. The sealing ring groove in the coupling shall be of the same design as the groove in cast iron fittings and valves available from local water works supply distributors. Where indicated, restrained joint pipe shall be ductile iron pipe. No restrained joint PVC pipe will be allowed.

- D. **Joint Deflection:** Deflection at the joint shall not exceed 1.5 degrees or the maximum deflection recommended by the manufacturer. No deflection of the joint shall be allowed for joints that are over-belled or not belled to the stop mark.

2.3 PIPE SCHEDULE

Pipe Designation or Pipe Class	Nominal Diameter, inches	Maximum Sustained Pressure, P_w, psi	Cover Range, feet	Trench Condition Outside Diam+feet	Minimum Compaction, percent
80-10	30	10	6	OD+2	95
80-5	48	5	4	OD+2	95

2.4 PIPE SCHEDULE SUBSTITUTIONS

- A. Internal pipe pressures allow for use of Class 80 psi (DR 51) pipe. However, based on availability and lead time from manufacturer, CONTRACTOR may propose use of Class 100 psi (DR 41) pipe.

2.5 FITTINGS

- A. Fittings shall be ductile iron conforming to AWWA C110, Class 150. PVC pipefittings shall be mechanical joint.
- B. Each fitting shall be clearly labeled to identify its size and pressure class.

PART 3 -- EXECUTION

3.1 GENERAL

- A. Laying, jointing, testing for defects and for leakage shall be performed in the presence of the ENGINEER, and shall be subject to approval before acceptance. Material having defects will be rejected and the CONTRACTOR shall promptly remove such defective materials from the Site.
- B. Installation shall conform to AWWA M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements or modifications herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 HANDLING AND STORAGE

- A. **Handling:** Pipe, fittings, and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings, and accessories shall be cleaned, and shall be maintained in a clean condition. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings, or any other pipe-related material be dropped or dumped into trenches.
- B. **Storage:** Pipe should be stored, if possible, at the Site in unit packages provided by the manufacturer. Caution shall be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe shall be stored in such a way as to prevent sagging or bending and shall be protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Store gaskets in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.3 TRENCHING AND BACKFILL

- A. Trench excavation and backfill shall conform to the requirements of Section 31 30 00 - Earthwork. The minimum backfill compaction in the pipe zone shall be 95 percent of maximum density per ASTM D 2922.

3.4 INSTALLATION

- A. Bell-and-spigot pipe shall be laid with the bell end pointing in the direction of laying. Pipe shall be graded in straight lines, taking care to avoid the formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable. At the end of each day's work, open ends of pipe shall be closed temporarily with wood blocks or bulkheads.
- B. Pipe shall be supported at its proper elevation and grade, care being taken to secure firm and uniform support. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the pipe bed, with recessed excavation to accommodate bells, joints and couplings. Anchors and supports shall be provided where indicated and where necessary for fastening work into place. Fittings shall be independently supported.
- C. Short lengths of pipe shall be used in and out of each rigid joint or rigid structure. Piping that does not allow sufficient space for proper installation of jointing material shall be replaced by one of proper dimensions. Blocking or wedging between bells and spigots will not be permitted.
- D. Joints shall be installed according to manufacturer's recommendations. Trenches shall be kept free of water until joints have been properly made. The maximum combined deflection at any coupling shall be in accordance with the manufacturer's recommendations.
- E. Pipe shall be cut by means of saws, power driven abrasive wheels, or pipe cutters that will produce a square cut. No wedge-type roller cutters will be permitted. After cutting, the

end of the pipe shall be beveled using a beveling tool, portable type sander, or abrasive disc.

3.5 SERVICE CONNECTIONS

- A. **Service Connections:** Direct tapping will not be permitted. Double strap bronze service clamps shall be used for all service connections. Service clamps shall have a bearing area of sufficient width along the axis of the pipe, so that the pipe will not be distorted when the saddle is made tight. An internal shell cutter shall be used to drill through the corporation stop to minimize PVC shavings, retain the coupon, and reduce stress. Single fluted shell cutters or twist drills are not acceptable. Lubricate the cutting and tapping edges of the tool with cutting lubricant. Make the cuts slowly and use the follower very lightly - do not force cutter through pipe wall. Shell cutter shall have sufficient throat depth to handle the heavy wall PVC pipe. Maximum outlet size permitted with service clamps or saddle is 2-inches.
- B. Tapping sleeves and valves shall be used for outlet sizes greater than 2-inches in diameter. Tapping sleeves shall be assembled and installed in accordance with the manufacturer's recommendations.

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**SECTION 35 20 18 – FABRICATED STEEL SLIDE GATES
(AWWA C561 MODIFIED)**

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide slide gates, complete and operable, in accordance with the Contract Documents. This specification relates to the design, materials of construction, fabrication, and supply of epoxy coated cast iron and stainless steel slide gates as shown on the Contract Drawings. See the Gate Schedule on the Contract Drawings for individual gate sizes and seating / unseating head requirements.
- B. Slide gates (**SG-1 and SG-2**) shall be of the self-contained type with the guides designed to mount embedded in a channel or vault wall.
- C. Slide gates (**SG-3 and SG-4**) shall be of the self-contained type with the guides designed to flush mount to a vault wall.
- D. The requirements of Section 35 20 00 – Valve and Gate Actuators, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C561	Stainless Steel Slide Gates
ASTM A276	Stainless Steel Bars and Shapes
ASTM B21	Naval Brass Rod, Bar, and Shapes
ASTM B584	Copper Alloy Sand Castings for General Applications

1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals, for ENGINEER’s review and approval.
 - 1. Submit the following:
 - a. drawings of gates, frames, slides, and actuators
 - b. design load calculations for deflection at the maximum expected head
 - c. calculations for the lifting force generated by 40 pounds effort on the handwheel or crank in order to operate the gate.
- B. Technical Manuals

1. Submit complete technical manuals, including printed instructions for proper maintenance, lubrication, and complete parts list indicating the various parts by name, number, and exploded view where necessary.
2. A list of recommended spare parts for the OWNER to store at the facility shall be included.

1.4 QUALITY CONTROL

- A. **Leakage Allowance.** The leakage allowance for slide gates under the design seating and unseating heads shall be less than 70 percent of the latest AWWA C561 standard not to exceed 0.07 gpm per foot of sealing perimeter. Leakage tests shall be completed in the field.
- B. Equipment Factory Testing
 1. Each gate shall be factory-assembled and functionality-tested prior to delivery to the Site.
 2. Test certificates shall be submitted.
- C. Equipment Field Testing
 1. The CONTRACTOR shall be responsible for the coordination of the tests of each hydraulic gate in the presence of the manufacturer's factory service representative.
 2. Excessive leaks shall be corrected and the equipment retested until found to be satisfactory.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. Installation and Startup Assistance
 1. Service and testing assistance by the Manufacturer's engineering representative for each gate shall be furnished to the CONTRACTOR during installation and startup. Manufacturer shall assume a minimum of two (2) full days of on-site technical assistance services plus travel time days to and from the project site.
- B. Instruction of OWNER's Personnel
 1. During the above two (2) on-site days of service, The CONTRACTOR shall arrange for the Manufacturer's engineering representative to provide a minimum of 1 to 2 hour period to instruct the OWNER's personnel in the operation and maintenance of the equipment.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. **Standards.** Where this section does not provide specific guidance on gate requirements, the gates shall comply with the following Standards:

1. AWWA C561 Stainless Steel Slide Gates

B. **Self-Contained Gates.** Gates shall be new and of current manufacture, adequately braced, totally self-contained gates in order to prevent warping and bending under the intended use.

C. **Dimensions.** Gate actuators shall be sized, selected, and furnished by the gate manufacturer. Nominal gate dimensions shall be for concrete wall openings as shown on the contract drawing (see **Sheet C102** and **Sheet C302**) and as follows:

1. **SG-1 Concrete Channel:** 4'-0" wide by 2'-0" tall (Concrete channel open area)
2. **SG-2 Concrete Channel:** 4'-0" wide by 2'-0" tall (Concrete channel open area)
3. **SG-3 Spool Diameter:** 2'-6" SQ
4. **SG-4 Spool Diameter:** 1'-6" SQ

D. Gate actuators throughout the project shall be products of a single manufacturer.

E. **Mounting Requirements for Self-Contained Gates in Handrail System.**

1. Where a gate is mounted in an opening between 2 sections of handrail, additional horizontal members shall be added to the gate frame to match the handrail, guardrail, and kickplate spacing of the adjacent railing.
2. Horizontal members shall be arranged such that the railing will not interfere with operation of the actuator.

2.2 FABRICATED SLIDE GATES (**SG-1 through SG-4**)

A. **Gate Schedule**

Equip. No. & Location	Gate Open Area (inches)	Rated Seating Head* (ft)		Flush Bottom Seal Req'd?	Motor Operator
		Max. Unseating	Max. Seating		
SG-1 Intake Structure	48"W x 24"H	3.0 feet	0 feet	Yes	Manual handwheel
SG-2 Intake Structure	48"W x 24"H	3.0 feet	0 feet	Yes	Manual handwheel
SG-3 Flow Splitter Box	30" Diameter	0 feet	9 feet	Yes	Manual handwheel
SG-3 Flow Splitter Box	16" Diameter	0 feet	7 feet	Yes	Manual handwheel

* Head defined from gate centerline elevation.

B. **Construction Materials**

1. Materials employed in the manufacture and installation of the hydraulic gates and operators shall be suitable for the intended application. Material not specifically called for shall be high-grade, standard commercial quality, free from defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended.
2. Unless otherwise indicated, materials of construction shall be as indicated below. Aluminum shall not be allowed for use in these gates
3. Materials used in the fabrication of the slide gates shall conform to the material standards indicated below:

Description	Material Standards
Disc & Stiffeners	ASTM A276, Type 304 Stainless Steel
Yoke Support Beam	ASTM A36 Structural Steel or ASTM A276, Type 304 Stainless Steel
Frame & Guides	ASTM A276, Type 304 Stainless Steel
Stem and Coupling	ASTM A276, Type 304 Stainless Steel
Stem Guides (at base of Yoke or integral to pedestal style)	ASTM A276, Type 304 Stainless Steel with UHMW bushing
Stem Cover	Transparent plastic pipe with UV inhibitors, Sched. 40 minimum
Disc Seats	UHMW Polyethylene, ASTM D4020
Invert (Base) Seal	For flush bottom gates: Embed "Q-bottom" Neoprene / rubber seal by Waterman or type "Hy-Q" stepped seal by Rodney Hunt. Embeds shall be ASTM A167, A 276, Type 304 Stainless Steel For non-flush bottom gates: Frame Mounted Invert Seal, Neoprene / Rubber, ASTM D 2000, Grade AA625.
Side and Top Seals	"J-bulb" Type or Self-Adjusting Neoprene Cord Seals, Neoprene / Rubber, ASTM D 2000, Grade AA625.
Metal Contact Surfaces for Seals (invert sill & J-side seals where used)	ASTM A167, A 276, Type 304 Stainless Steel
Fasteners (including studs, anchors, assembly bolts, nuts)	ASTM F593, F594, Type 316 Stainless Steel

and hardware)	
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- C. **Design Hydraulic Loading.** Each slide gate shall be designed for the hydraulic loading characteristics as defined by the maximum seating head and unseating head conditions as specified in the Gate Schedule above.
- D. **Gate Design.** All fabricated steel gate components shall have a minimum thickness of 1/4-inch unless specified otherwise.
1. **Slide Cover (Disc) and Stiffeners.** The gate slide cover (disc) shall consist of a flat plate reinforced with structural or formed members welded to the plate.
 - a. The disc is to be designed to limit deflection of the gate to 1/720 of its span or 1/16-inch at the sealing surface of the gate under maximum specified head.
 - b. The working design stresses shall not exceed the lesser of 40-percent of the yield strength or 25-percent of the ultimate strength of the material.
 2. **Frame / Guides.** The gate frame shall consist of guides, invert member, and a fabricated operator yoke assembly. The guides shall be of a sandwiched type construction built up of plates, angles, and formed shapes. The guide slot shall engage the disc plate a minimum of 1-inch.
 - a. Disc and frame shall be designed to resist a hydraulic load of the gate being closed under maximum seating head conditions and also opening the gate under these conditions
 - b. The working stresses shall not exceed the lesser of 40% of the yield strength or 25% of the ultimate strength of the material.
 - c. The disc and frame design shall be arranged such as to allow simple removal of the disc from the frame, when required for maintenance.
 - d. **For non-flush bottom gates to a concrete floor,** frames shall be furnished with a flush seal arrangement. A resilient seal with a minimum width of exposed face of 1.375" shall be securely attached to the frame along the invert, and shall extend to the depth of the guide groove. The resilient seal extrusion shall be constructed to be ribbed and self-retaining. For non-flush bottom gates, invert seal designs that require mechanical retention are not allowed.
 - e. **For flush bottom gates to a concrete floor,** a stainless steel embed shall be grouted by the CONTRACTOR into a block-out of the concrete in the channel floor. Either of the following two design approaches are acceptable for the flush bottom seal:
 - 1) A 3-inch deep block-out shall be provided where the stainless steel embed shall retain the neoprene / rubber seal and prevent its dislodging during normal water flow operation over the gate invert. ("Q" bottom seal by Waterman), or

- 2) A stainless steel L-bracket piece shall be cast or grouted into the floor to be flush with the floor invert. The neoprene step seal shall be fastened to the bottom of the gate structure and shall make a continuous seal with the stainless embed (stepped "HY-Q" flush seal by Rodney Hunt)
3. **Steel Yoke Support Beam.** Gate lifting and lowering shall be supported by a steel support framing system (yoke) designed and fabricated by the gate Manufacturer. The yoke shall be designed and fabricated according to the following:
 - a. Designed to span the open width (W) on the top deck as shown on the Contract Drawings.
 - b. Designed for the maximum output of the gate hoist.
 - c. Designed to transmit the full weight of the gate plus the hydraulic (friction) load created when the gate is closed and the seating heads are as defined above. The deflection not to exceed $W/360$, where W equals the width of the opening across which the Yoke is spanning.
 - d. Yoke shall be designed out of parallel C or box-channel members which shall not exceed 12-inches in height. The working stresses shall not exceed the lesser of 40% of the yield strength or 25% of the ultimate strength of the material.
 - e. Yoke shall be designed with an integral stem guide to be attached to the bottom of the yoke. Stem guide shall have bronze or UHMW or other approved bushing to guide the stainless steel stem.
4. **Seals.** Resilient seals shall be placed along the top, bottom, and both sides of the gate to prevent leakage. The seal attaching hardware shall be stainless steel and attached in a manner to permit replacement of the seals. The gate side and top seals may be of the "J-bulb" type style or may be designed as a self-adjusting neoprene cord seal as described below.
 - a. For the self-adjusting cord seal, the UHMW seats shall impinge on the slide (disc) by way of a continuous loop neoprene cord seal.
 - b. J-bulb seal corners shall be formed by continuous molded sections. Joints between the molded corners and top or side seals shall be a square butt type located a minimum of 12-inches from the corner. The molded corner shall be bonded to the top and side seal and assembled to the gate disc in the manufacturer's shop. Mitered joints shall not be used.

"J-bulb" type seals or self-adjusting neoprene cord seals shall be retained by the frame to restrict leakage to the following limits:

 - c. Under a design seating head (measured from gate invert), perimeter leakage (in GPM per foot of seating perimeter) shall not exceed 0.07 gpm / lineal foot of gate perimeter.
 - d. Under a design unseating head (measured from gate invert), perimeter leakage (in GPM per foot of seating perimeter) shall not exceed 0.07 gpm / lineal foot of gate perimeter.

5. **Guide Slots, Sill, and Yoke.** Prefabricated guide slots, sill, and yoke shall be provided as follows:
 - a. Guides shall be extended to support no less than 1.66 times the height of the slide in the open position (as measured from the invert of the gate opening). For self-contained gates the frame shall extend at least 36 inches above the operating platform or as shown in the contract drawings. The yoke shall be designed to support the thrust of the actuator with a minimum safety factor of 4 in regard to the ultimate tensile, compressive and shear strengths of the materials. (*Manufacturer is referred to section 4.4.5.1 of AWWA C561-12*)
6. **Stems.** Stems shall be of solid construction, of the **rising-stem** type with threads of the cut Acme type. Stems shall be designed to transmit in compression a minimum of two times the rated output of the hoist at 40 pounds effort on the crank or handwheel.
 - a. The L/r ratio of the unsupported stem shall not exceed 200.
 - b. Stem guides, where required to limit the unsupported stem length, shall be UHMW or bronze bushed.
 - c. All gates having widths greater than two times their height shall be provided with two lifting devices connected by a tandem shaft for simultaneous operation.
7. **Stem Covers.** Rising stem gates shall be provided with clear stem covers to provide indication of gate position, permit inspection of the stem threads, and to protect the stem from contamination. Vent holes shall be provided to prevent condensation.

E. Anchor / Mounting Bolts

1. The diameter, length, quantity and location of the slide gate anchor hardware shall be determined by the slide gate Manufacturer and clearly shown in installation literature.
2. All anchor hardware including studs, adhesive anchor bolts, other bolts, nuts and washers shall be provided by the gate Manufacturer to the CONTRACTOR for installation. Use of expanding style wedge mechanical anchors shall not be allowed.

F. Wall Thimbles

1. F-style wall thimbles be required of the new fabricated slide gates to be furnished. Rather, gate frames shall be mounted to the concrete walls using 316 stainless steel epoxy adhesive anchor bolts per Part 2.2.E above.

G. Lifting Device / Gate Manual Actuator

1. Provide lifting devices complete with stem, lifting nut, intermediate supports with steady bushings, stem cover, indicator, and gear reducer, hand wheel, crank, electric or hydraulic cylinder, where indicated.
2. The lifting devices shall be weatherproof.

3. Pedestal Mounting
 - a. The lifting devices shall be mounted on pedestals constructed of cast iron or fabricated steel.
 - b. The pedestals shall have an ample base or bracket area to evenly distribute the load to the supporting concrete structure or yoke of the gate.
4. The centerline of the manual actuator shall be approximately 3 feet above the base for pedestal-mounted actuators, and approximately 3.5 feet above the floor for frame-mounted actuators.
5. Slide gate hoist heads shall be constructed of cast iron.
6. The operating nut shall be constructed of solid bronze, in accordance with ASTM B 584.
7. Operating thrust shall be taken on roller or ball bearings.
8. Parts shall be provided with an alternative lubrication system.
9. Handwheel Crank
 - a. The unit shall be designed for a 40–pound maximum effort on the crank in order to operate the gate.
 - b. Clockwise movement of the handwheel shall close the gate.
 - c. The operating crank shall be easily removable in order to facilitate the use of a portable power operator.

H. **Welding**

1. All welding shall be performed in accordance with AWS D1.1. All welders shall be certified with current AWS welder certifications.

I. **Coatings**

1. Any exposed ferrous surfaces (non stainless steel components) shall be blasted to SSPC SP-10 and receive coating system No. 51 (Polyamide epoxy), prior to their assembly. The polyamide epoxy coating system shall meet the following requirements:
 - a. Product shall be a high-build polyamide cure epoxy with a maximum VOC content of 366 g/L. Product shall be suitable for long-term immersion in water and resistant to corrosion.
 - b. Product shall be applied in a minimum of two coats and shall have a total dry film thickness (DFT) of no less than 12 mils.
 - c. Acceptable product manufacturers include Ameron Amercoat 370, or Tnemec Pota Pox Series 20 or Carboline Carboguard 61.

2. Components not requiring painting, (e.g., non-metallic seating surfaces and all 316 stainless steel surfaces) shall be protected from overspray during the ferrous surface coating process.

J. Gate Manufacturers, or Equal

1. Golden Harvest
2. Whipps
3. Rodney Hunt Company
4. Waterman Industries

PART 3 -- EXECUTION

3.1 FACTORY TESTING

- A. The slide gates shall be factory tested in accordance with the requirements of this section and AWWA C561.

3.2 WORKMANSHIP AND TOLERANCES

- A. Workmanship and tolerance allowances, metal fits, and finishes when not definitely specified shall conform with the best modern shop practices in the manufacture and fabrication of materials of the type covered by these specifications and also with the governing requirements of AWWA C513.

3.3 STORAGE AND INSTALLATION

- A. The CONTRACTOR shall handle, store, and install the fabricated roller slots, gate operating mechanism, stem guides, and accessories in strict accordance with the Manufacturer's approved shop-drawings and recommendations.
- B. The slide gates shall be installed in accordance with the Manufacturer's detailed technical installation procedures and recommendations
- C. As applicable, Operators shall be located to avoid interference with handrails and structural members.

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**SECTION 40 71 13
INLINE MAGNETIC FLOW METERS**

PART 1- GENERAL

1.01 SUMMARY

A. Electromagnetic flow meters for permanent installations both above and below ground. The meters shall utilize bipolar pulse DC coil excitation to measure voltage induced by the flow of conductive liquid through a magnetic flux. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second.

1.02 SUBMITTALS

A. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer's certifications, Manufacturer's Field Reports

B. Product Data:

1. Dimensional Drawings.
2. Materials of Construction:
 - a. Sensor.
 - b. Liner.
 - c. Electrodes.
 - d. Flanges.
3. Measurement accuracy.
4. Range and range ability.
5. Enclosure Rating.
6. Classification Rating.
7. Power:
 - a. Voltage.
 - b. Wattage.
8. Output options.

1.03 QUALITY ASSURANCE

A. Manufacture facilities shall be certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
- B. Any instruments that are not stored in strict conformance with the manufacturer’s recommendation shall be replaced.

1.05 PROJECT OR SITE CONDITIONS

- A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.06 WARRANTY

- A. The meter shall have standard one year warranty from date of shipment and if the meter is commissioned by a factory certified technician, the warranty is extended to three years from the date of shipment.

1.07 MAINTENANCE

- A. Provide all parts, necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

1.08 LIFECYCLE MANAGEMENT

- A. Instrument documentation, like original calibration certificates, manuals and product status information shall be accessed via a web enabled system with a license. The instrument-specific information shall be accessed via its serial number. When services are provided by an authorized service provider the services information like subsequent field calibrations shall be archived and accessible via this web enabled system.

PART 2 - PRODUCTS

2.01 MAKE AND MANUFACTURER

- A. Electromagnetic flow meter make and manufacture shall be identified on Idaho Department of Water Resources list of approved closed conduit flow meters.
- B. MAGNETIC METER SCHEDULE (**FM-1 and FM-2**)

Equip. No. & Location	Diameter (inches)	Power Source	Manufacture
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FM-1 Meter Vault	30 inches	DC Battery	Glotech Gem or equal
FM-2 Meter Vault	16 inches	DC Battery	Glotech Gem or equal

2.02 MANUFACTURED UNITS

A. The flow meter shall be a flanged sensor (by application and instrument schedule) which complies with AWWA C751 and transmitter which may be mounted integral (compact) to the sensor or remote with interconnecting cables up to 650 feet in length.

1. The flow metering system shall be microprocessor-based and possess a non-volatile memory to store the sensor calibration and transmitter setup information. The electronics shall be interchangeable for meters sizes 1"- 90".
2. The sensor shall be the proper size to measure the design flow rate of the piping and measure bi-directional flow as a standard.
3. The sensor shall consist of a stainless steel flow tube with ANSI B16.5 or AWWA C207 carbon steel or stainless steel flanges. The flanges shall be Class 150 for 24" and smaller, and AWWA Class D for 28" and larger (listed by the application and instrument schedule).
 - a. Sensors from 1"-12" shall have fixed (welded) or rotating lap joint flanges.
 - b. Sensors from 14"-120" shall have the flanges welded to the sensor body.
4. The sensor liner and electrode material shall be chosen to be compatible with the process fluid. All fluids require a minimum conductivity of 5µS/cm (20µS/cm for deionized water).
5. The sensor tube shall be lined with polyurethane, hard rubber or PTFE in accordance with NSF-61 based upon the size of the flow meter and the process media conditions.
6. The sensor shall house two measuring electrodes, a grounding electrode, and one for physical empty pipe detection. The electrodes shall be bullet-nosed shaped and made of 316L SS or Alloy C22 (listed by the application and instrument schedule).
 - a. Optional unrestricted mounting magnetic flowmeter sensor for applications without the typical inlet/outlet straight pipe run requirements. The full bore magnetic flowmeter in sizes 1"-120" shall maintain zero pressure loss while achieving 0.5% of rate accuracy even when mounted directly before or after a piping elbow, T-fitting or insertion device. This flow tube shall have four measuring electrodes (sizes 1-2.5") and six measuring electrodes (sizes 3"-120") plus a grounding electrode and an empty pipe

electrode. Optional 0.2% of rate calibration is available with this sensor design however the flowmeter must be installed with the proper upstream (5 diameters) and downstream (2 diameters) pipe run requirements.

7. The external sensor housing shall enclose the coil assemblies and internal wiring. The materials shall be designed and constructed to prevent moisture ingress and promote corrosion resistance.
8. The electrode circuit shall have a minimum impedance of 10^{12} ohms to overcome moderate coating buildup.
9. The sensor shall be rated for NEMA 4X service as standard.
 - a. An optional sensor rating for NEMA 6/IP67 service shall allow for temporary immersion in water depths of 10 feet for 168 hours OR 30 feet for 48 hours.
 - b. An optional sensor rating for NEMA 6P/IP68 service shall allow for permanent immersion in water depths up to 10 feet.
10. If NEMA 6 or 6P is specified in the instrument schedule, the transmitter shall be remotely mounted and custom length cables shall be attached at the factory.
11. In the event of industrial treatment or corrosive/brackish environments, the flow sensor shall be painted and certified according to ISO-12944 corrosion class. Third party modification or sensor preparations will not be accepted without type test documentation to support the exposure conditions, depth and duration of resistance.

B. The transmitter shall be a three-stage microprocessor controller mounted integrally or remotely as specified in the instrument schedule. The transmitter shall incorporate a universal 100-240 VAC/18-30 VDC power supply. The transmitter housing will carry a NEMA 4X rating and shall be constructed to prevent moisture ingress, promote corrosion resistance, and be impervious to saline environments.

1. The transmitter shall allow local programming that can be operated through the enclosure window without opening the electrical enclosure.
2. The transmitter display shall indicate simultaneous flow rate and total flow with 3 totalizers (forward, reverse and net total) and user-selectable engineering units, readout of diagnostic error messages, and support 12 standard languages.
3. The transmitter shall safeguard against entering of invalid data for the particular meter size and all programming parameters shall be access-code protected with a minimum requirement of dual passwords according to data sensitivity.
4. The transmitter output shall be specified, as either:
 - a. 4-20mA HART®, 0-20mA, pulse/frequency/switch.

- b. Modbus RS-485
 - c. Profibus® DP
 - d. Or a standard, unmodified form of Ethernet (ex. EtherNet/IP™)
5. The transmitter output(s) shall be integral to the magnetic flowmeter transmitter electronics and using an external third party signal converter is unacceptable.
 6. There shall be no limitation of transmitter operational capability or diagnostic dependency between integral and compact mounting orientation.
 7. The transmitter output selected must be supported by add-on instructions (AOI), Level 3 add-on profiles (AOP), device drivers (DD), general station description (GSD) files, instructions and pre-engineered code.
 8. The transmitter shall support commissioning options via a service interface or device driver less operation via an internal web server accessible through a transmitter accessible RJ-45 Ethernet port or a WLAN (Wireless Local Area Network) connection as specified.
 9. The transmitter shall retain all setup parameters and accumulated measurements internally in non-volatile memory in the event of power failure. The memory unit shall be transferrable from a damaged unit or used for a duplicate device with no loss of device parameters or data stored.
 10. The transmitter shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.
 11. Device failure modes, self-monitoring characteristics and remedy diagnosis shall follow NAMUR standards NE 43 and NE 107.
 12. The transmitter shall provide access to service and monitoring parameters designed to identify transient or permanent process influences.
 13. The transmitter and sensor shall include a method to verify flow meter performance to the original manufacturer specifications.
 - a. The system shall be traceable to factory calibration using a third party, attested onboard system pursuant to ISO standards.
 - b. The verification technique shall not require external handhelds, interfaces, special tooling or electrical access for a verification to be performed.
 - c. The transmitter shall store up to eight verifications in the microprocessor.
 - d. A verification of the system shall be possible at any time, locally or remotely, on demand and under process conditions.

- e. f. The verification report shall be compliant to common quality systems such as ISO 9000 7.6.a to prove reliability of the meter specified accuracy.

2.03 ACCESSORIES

- A. Stainless steel tag - labeled to match the contract documents.
- B. Provide grounding rings, as per manufacture's recommendations, if required
- C. Provide sun shield for outdoor installations as required per the instrument schedule.

2.04 SOURCE QUALITY CONTROL & CALIBRATION

- A. Magnetic flow meters shall be factory calibrated on an ISO-17025 accredited test stand per "General Requirements for the Competence of Testing and Calibration Laboratories" with certified accuracy traceable to NIST.
- B. Evidence of accreditation shall originate from a national verification agency such as A2LA.
- C. Each meter shall ship with a certificate of a 2-point calibration report exceeding stated standard accuracy of 0.5% of rate.
 - 1. Optional calibration to 0.2% of rate shall be performed.
 - 2. An optional performance calibration for a Flat Accuracy Specification shall be performed In the event of low initial design flow rate.
- D. A real-time computer generated printout of the actual calibration data points shall indicate apparent and actual flows. The flow calibration data shall be confirmed by the manufacturer and shipped with the meters to the project site.
- E. The manufacturer shall provide complete documentation covering the traceability of all calibration instruments.
- F. The manufacturer shall provide ISA data sheet ISA-TR20.00.01 as latest revision of form 20F2321. The manufacturer shall complete the form with all known data and model codes and dash out the inapplicable fields. Incomplete data sheets submitted will result in a rejected submittal.

2.05 SAFETY

- A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, National Electric Code latest edition.
- B. All devices shall be certified for use in hazardous areas: Class 1, Div. 2, Groups B/C; temperature rating T3 (200 deg. C)
- C. All devices shall be suitable for use as non-incendive devices when used with appropriate non-incendive associated equipment. Devices with intrinsically safe ratings will normally be acceptable with vendor's approval.

- D. Electrical equipment housing shall conform to NEMA 4X classification.
- E. Non-intrinsically safe electrical equipment shall be approved by a Nationally Recognized Testing Laboratory (NRTL) such as FM, UL, CSA, etc. for the specified electrical area classification.
- F. Electrical equipment specified as intrinsically safe shall qualify as “simple apparatus” or NRTL approved intrinsically safe equipment per ANSI/ISA-RP12.6 “Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations,” latest edition.

PART 3-EXECUTION

3.01 EXAMINATION

- A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.
- B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

- A. CONTRACTOR is responsible for installation of flow meters in accordance with manufacturer’s instructions. All dimensions and requirements for connection of inline flow meters to the pipeline shall be the responsibility of the CONTRACTOR and shall be performed in accordance with manufacturer’s documentation.
- B. As recommended by the manufacturer’s installation and operation manual.
- C. Specific attention should be given to the following technical requirements:
 - 1. Verify ground rings (if required) have been installed according to the manufacturer recommendations.
 - 2. Reduced inlet installations must either be specified in the device ordering information or accompanied by manufacturer’s documented evidence of third party testing and data collection in comparison to a traceable standard.

3.03 FIELD QUALITY CONTROL

- A. Each instrument shall be tested before commissioning and the ENGINEER shall witness the interface capability in the PLC control system and associated registers.
 - 1. Each instrument shall provide direct programming capability through the PLC
 - 2. Each instrument shall provide direct control of totalizer reset functions through the PLC

3. Each instrument shall be supported with a device profile permitting direct integration in the PLC
- B. The ENGINEER shall witness all instrument verifications in the field.
- C. Manufacturers Field Services are available for start-up and commissioning by a Factory field service representative or a manufacturer's authorized service provider (ASP) – the warranty against manufacturing defects is three years.
 1. Manufacturer representative shall verify installation of all installed flow tubes and transmitters.
 2. Manufacturer representative shall notify the ENGINEER in writing of any problems or discrepancies and proposed solutions.
 3. Manufacturer representative shall perform field verification at the time of installation for long-term analysis of device linearity, repeatability and electronics health. A comparative report shall be generated for each meter tested.
 4. Manufacturer representative shall generate a configuration report for each meter.

3.04 ADJUSTING

- A. Verify factory setup of all instruments in accordance with the Manufacturer's instructions.

3.05 PROTECTION

- A. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning:
 - a. The ENGINEER shall be the sole party responsible for determining the corrective measures