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CITY OF TEMPE, ARIZONA
PUBLIC WORKS DEPARTMENT
DIVISION OF ENGINEERING

Contract Documents

for

RIO SALADO TOWN LAKE DAM FACILITIES SCHEDULE B

PROJECT NO. 946523B

CITY COUNCIL MEMBERS

Mayor - Neil Giuliano

Linda Spears

Dennis Cahill

P. Ben Arredondo

Joseph P. Spracale

Joseph Lewis

Carol E. Smith

1996

SPECIAL NOTICE

BIDS SHALL BE SUBMITTED IN A SEALED ENVELOPE. THE OUTSIDE LOWER RIGHT HAND CORNER SHALL BE MARKED:

BID OF _____, CONTRACTOR,

FOR: **RIO SALADO TOWN LAKE DAM FACILITIES SCHEDULE B**

PROJECT NO. 946523B

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CITY OF TEMPE, ARIZONA
PUBLIC WORKS DEPARTMENT
DIVISION OF ENGINEERING

NOTICE TO CONTRACTORS

RIO SALADO TOWN LAKE DAM FACILITIES SCHEDULE B

PROJECT NO. 946523B

SEALED BIDS will be received by the City of Tempe, Arizona, Public Works Administration, City Hall West Garden Level, 31 East 5th Street, Tempe, Arizona 85281, until 9:30 a.m. November 5, 1996. At that time, bids will be opened and publicly read aloud in the Public Works Conference Room. Bids received after the time specified will be returned unopened.

The proposed work will consist of installation of **CONSTRUCTION OF RUBBER DAM FOUNDATIONS AND INSTALLATION OF 16' AND 5' HIGH RUBBER DAMS ACROSS THE SALT RIVER TWO CONTROL BUILDINGS, PUMP BACK SYSTEM, ASSOCIATED PIPING AND APPURTENANCES. THE RUBBER DAMS, BLOWERS, AND CONTROL SYSTEM WILL BE SUPPLIED BY THE CITY** together with associated work and shall be accomplished in accordance with the "Maricopa Association of Governments Uniform Standard Specifications and Standard Details for Public Works Construction", and "The City of Tempe Supplements thereto" except as otherwise set forth in the Contract Documents.

A bid guarantee acceptable to the City of Tempe in the amount of 10% of the proposal shall be submitted with the proposal. Personal or individual surety bonds are not acceptable. The City requires all bonding companies and liability and excess insurance carriers to have a rating of "A-" or better as listed in the most recent "Best Key Rating Guide (Property and Casualty)" published by A.M. Best Company.

A set of plans, specifications and other contract documents may be purchased from the City Engineering Division (350-8200) upon payment of fifty dollars ($50.00) or checked out for a ten (10) day review period upon deposit of fifty dollars ($50.00).

Work shall not start until after the date of issuance of Notice to Proceed and shall be completed within four-hundred six (406) calendar days thereafter. See construction schedule sequencing in the Special Provisions.

The City of Tempe reserves the right to reject any and all bids and to waive any informality in the bids received. Award will be made or bids rejected within thirty (30) days after bid opening.

"NOTICE: THIS CONTRACT CONTAINS AN EXCLUSIVE AND MANDATORY PARTNERING AND AN ALTERNATIVE DISPUTE RESOLUTION PROCESS FOR THE EFFICIENT AND EXPEDITIOUS RESOLUTION OF ALL CLAIMS WHICH MAY ARISE FROM THIS CONTRACT AND OTHER CONTRACTS CONTAINING THESE PROVISIONS FOR THE PROJECT."

_____

Judith Greenberg
Public Works Director

GENERAL PROVISIONS

SPECIFICATIONS

All work done under this contract shall be accomplished in accordance with the Maricopa Association of Governments Uniform Standard Specifications and Standard Details for Public Works Construction and the City of Tempe Supplement thereto except as modified in these Special Provisions.

In the event of any conflict between these Project Specifications and the requirements of the above referenced specifications, codes and regulations, these Project Specifications shall prevail. All bids to receive considerations shall be made in accordance with the General Conditions of the Standard Specifications as set forth hereinafter.

SECURING DOCUMENTS

Copies of specifications, special provisions, and other proposed contract documents are on file in the office of the City Engineer, City Hall, 31 East Fifth Street, Tempe, Arizona, and are open for public inspection. A set of such documents may be obtained from the City Engineer, upon payment of fifty dollars ($50.00), which payment will not be returned. In addition, a set is available to be checked out for a period of ten (10) days upon deposit of fifty dollars ($50.00). If the plans and specifications are returned in the original condition (without marks or alterations) and are returned within the specified ten (10) day period, the deposit will be returned. If either of these conditions are not met, the deposit will not be returned but will instead be kept as payment.

INTERPRETATIONS OF DRAWING AND DOCUMENTS

If any person submitting a bid for the proposed contract is in doubt as to the true meaning of part of the specifications or other contract documents, or finds discrepancies in, or omissions from the specifications, he may submit to the Tempe City Engineer a written request for an interpretation or correction thereof. The person submitting the request will be responsible for its prompt delivery. Any interpretations or corrections of the proposed documents will be made by Addendum duly issued, and a copy of each addendum will be mailed or delivered to each person receiving a set of such documents. The City of Tempe will not be responsible for any other explanation or interpretations of the documents.

ADDENDA

Addenda issued during the time of bidding shall be attached to and made a part of the contract documents.

BID SECURITY

Each proposal shall be accompanied by a certified check, cashier's check, or bid bond acceptable to the City in an amount equal to at least ten per cent (10%) of the proposal, payable without condition to the City as a guarantee that the bidder, if awarded the contract, will promptly execute such a contract in accordance with the proposal and in manner and form required by the Contract Documents. Each bid bond shall be executed by a surety company or companies duly authorized to do business in the state and all bond documents shall be executed pursuant to the requirements of Arizona Revised Statutes. The bid security of the two lowest bidders will be retained until the contract is executed or other disposition is made thereof. The bid security of all bidders except the two lowest will be returned promptly after the award of contract.

PROPOSAL

Bids shall be properly executed upon the proposal form attached to and made a part of the contract documents, with items properly filled out. The signature of all persons signing shall be in longhand. The completed forms shall be without interlineations, alterations, or erasures. In case of an error in the extension of unit prices and the totals, the unit price shall govern.

Bids shall not contain any recapitulations of the work to be done. Alternative proposals will not be considered except as called for. No oral, telegraphic, or telephonic proposals or modifications will be considered.

IRREGULAR BIDS

Proposals may be considered irregular and may be rejected if any of the unit prices quoted in the bidding schedule are unbalanced, either above or below the amount of a reasonable bid price, to the potential detriment of the City.

AWARD OF CONTRACT

A contract will be awarded or bids rejected within 30 days after bid opening.

INSURANCE AND BOND RATING REQUIREMENTS

Personal or individual bonds are not acceptable.

Bonding companies and Liability and Excess insurance carriers shall be "Best Rated A-" or better as currently listed in the most recent "Best's Key Rating Guide (Property/Casualty)" published by the A.M. Best Company. This requirement does not apply to the Workmen's Compensation/Employers Liability portion on the Certificate of Insurance.

Each such bond SHALL be executed by a surety company or companies duly licensed to do business in the State of Arizona. The bonds shall be written or countersigned by an authorized representative of the surety who is either a resident of the State of Arizona or whose principal office is maintained in this State, and the bonds shall have attached thereto a certified copy of Power of Attorney of the signing official.

INSURANCE REQUIREMENTS

The Contractor's attention is directed to Section 103.6 of the Maricopa Association of Governments Uniform Standard Specifications for Public Works Construction and all such required insurance policies shall additionally provide full coverage of indemnity to the City as set forth below including an increase in the minimum limits to $5,000,000.00 combined single limit coverage. The proof of insurance shall be submitted to the City Engineer prior to execution of contract. Builders Risk Insurance shall be provided as applicable, in accordance with Section 103.6C.

BONDS REQUIRED

Bonds in the following amounts will be required at the time of executing the formal contract and must meet the requirements of Arizona Revised Statutes Title 34, Chapter 2:

1. Performance bond, one hundred percent (100%) of the contract price.
2. Payment bond, one hundred percent (100%) of the contract price.

EXECUTION OF CONTRACT AND BONDS

The form of the contract, which the successful bidder, as Contractor, will be required to execute and the form of bonds which he will be required to furnish, are included in the contract documents and should be carefully examined by the bidder. The successful bidder will be required to execute the bonds and the standard form of contract in three (3) original counterparts within ten (10) days after formal notice of award of contract. Failure to execute a contract and file satisfactory contract bonds as provided herein within 10 calendar days after the date of Notice of Award, shall be just cause for the cancellation of the award and the forfeiture of the bid security which shall become the property of the City of Tempe, not as penalty, but in liquidation of damages sustained. Award may then be made to the next lower responsible bidder or the work may be re-advertised as the City of Tempe may decide.

LICENSES

The Contractor must carry the appropriate State of Arizona contractor's license for the proposed work at the time of the bid. If the low bidder does not have the appropriate license, the City reserves the right to reject their bid and award it to the lowest bidder who has the appropriate license.

Prior to execution of the contract documents, the low bidder must possess a valid City of Tempe Transaction Privilege License and shall provide the Permit Number of such for validation.

EXAMINATION OF PREMISES

The Contractor shall visit the site of the project and shall fully acquaint himself with the conditions as they exist, so that he may fully understand the facility, difficulties and restrictions attending the execution of the work.

Bidders shall also thoroughly examine and be familiar with the specifications and other contract documents. The failure of the Contractor to obtain, receive or examine any addenda to the proposed contract documents, or to visit the site and acquaint himself with the conditions there existing, shall in no way relieve him from any obligation with respect to his proposal.

By submitting a proposal, the Contractor agrees that he has examined the site, specifications and other contract documents and accepts, without recourse, all site conditions and the proposed contract documents.

HAUL PERMIT

In any operation where more than one-tenth of an acre of surface area is disturbed and/or when unpaved onsite haul roads are used, the Contractor will obtain a Maricopa County Earth Moving Permit as required under Rule 200 of the Maricopa County Division of Air Pollution Control Requirements. This permit will require that a Control Plan to mitigate dust and tracking problems be submitted to the County for approval prior to issuance of the Earth Moving Permit. The Control Plan should be submitted to the City of Tempe for review prior to County submittal to ensure that all elements of the planned operation are covered. Please contact the Maricopa County Division of Air Pollution Control at 506-6700 for additional details.

In addition, all Contractors hauling fill or excavation materials where the haul exceeds 5000 cubic yards or when the duration of the haul is more than 10 working days are required to obtain a hauling permit before the hauling operation begins. Prior to receiving a hauling permit, the Contractor must submit the required certificate of insurance, a plan showing the proposed haul routes and a complete schedule of his hauling operation to the City of Tempe Transportation Division. Prior to submittal, the Contractor should contact Engineering Services for complete details.

INDEMNITY

To the fullest extent permitted by laws and regulation, the Contractor shall indemnify and hold harmless the City, its engineer, architect, their employees and agents, from and against all losses and expenses, direct, indirect or consequential, and all claims, demands, payments, suits, actions, recoveries, and judgments of every nature and description brought or recovered against them by any reason of any act, omission, negligence or claimed negligence of the City, its engineer, architect, their employees and agents, other than for loss or damage resulting from the sole negligence of the City, its engineer, architect, their employees and agents, arising from the work, completed work, or product under this contract.

In any and all claims against the City or any of its agents, or employees by any employee of contractor, subcontractor, or any person or organization directly or indirectly employed by any of them to perform or furnish any of the work under the contract or anyone for whose acts any of them may be liable, the indemnification obligation shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for the City or any person or organization under workers' or workman's compensation acts, disability benefit acts or other employee benefit acts.

PLANS TO THE SUCCESSFUL BIDDER

The successful bidder may obtain (7) sets of Specifications for this project from the office of the City Engineer, at no cost.

If he desires more than seven (7) sets, he shall be required to pay the reproduction cost of fifty dollars ($50.00) each.

START AND COMPLETION OF WORK

Work shall start as soon as practical after the starting date specified in the Notice to Proceed and shall be completed within four-hundred six (406) calendar days thereafter.

CONTRACTOR'S CONSTRUCTION SCHEDULE

Within ten (10) days after execution of the contract, the Contractor shall furnish the City Engineer a proposed Construction Progress Schedule, in the form of a Ghant Chart or Critical Path Method (CPM) diagram, indicating dates of commencement and completion of all major activities required in the contract. During construction, the Contractor shall maintain and revise the construction schedule to reflect changes or conditions encountered in the construction work.

CONTRACTOR'S REPRESENTATIVE

The Contractor shall at all times be present at the work in person or represented by a foreman or other properly designated agent. Instructions and information given by the Engineer to the Contractor's foreman or agent on the work shall be considered as having been given to the Contractor.

NON-DISCRIMINATION

In connection with the performance of work under this Contract, the Contractor agrees not to discriminate against any employee or applicant for employment because of race, religion, color or national origin. The aforesaid provision shall include, but not be limited to, the following: Employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship.

The Contractor agrees to post hereinafter in conspicuous places, available for employees and applicants for employment, notices to be provided by the Contracting officer setting forth the provisions of the Non-Discrimination clause.

RELOCATION OF UTILITIES

Except as otherwise provided in the plans or project specifications, all utilities in conflict with the new work will be relocated by the owner thereof.

MISCELLANEOUS REMOVAL AND RELOCATIONS

Miscellaneous removals and relocations shall be construed to mean the removal of all unsuitable materials whether designated or implied by the plans and specifications, and shall include but not be limited to the removal of such items as pipes, concrete, asphalt, block, brick, rock, metal, etc. of every nature and description, unless such items are specifically designated in a separate bid item. Also, certain items require temporary removal and reinstallation such as mail box stands, sign posts, survey monument frames and covers, etc., and are included in this category.

EXCESS MATERIALS

Excess or unsuitable material, broken asphaltic concrete and broken portland cement concrete shall be disposed of by the Contractor. The Contractor shall, prior to commencement of the work, submit a letter to the City Engineer stating the location of disposal site(s) for all excess material and certifying that he has obtained the property owner's permission for the disposal of all surplus material.

ENVIRONMENTAL REQUIREMENTS

The Contractor shall comply with all Federal, State, and Municipal regulations, laws, and policies relating to air, ground water quality, and water conservation. In addition, the following requirements are applicable for City construction projects.

1. Non-pick up sweepers will not be allowed except as required to make joints during chip sealing operations.

2. Water flooding of trenches with potable water will not be permitted.

3. All paints applied by sprayers shall be of a water-based type.

4. Provisions shall be made to prevent the discharge of construction silt, mud, and debris into City storm drains or streets.

5. Spills of oil, gas, chemical, or any other hazardous materials must be reported and removed by approved procedures. Mitigation measures shall be taken to prevent contamination of construction storage sites.

6. Concrete waste must be disposed of in an approved location and at least 25 feet from established landscaping.

7. City of Tempe refuse roll-off containers shall be used on City projects.

8. Hazardous wastes shall not be discharged into the City's sanitary sewers or storm drainage system. All waste products shall be disposed of in accordance with applicable regulations.

9. The discovery of archeological ruins or artifacts must be reported immediately, and excavation shall not resume in the identified area until approved by the Engineer.

10. The Contractor shall take whatever steps, procedures, or means to prevent abnormal, material spillage, or tracking conditions due to his construction operations in connection with the Contract. The dust control measures shall be maintained at all times during construction of the project, to the satisfaction of the City Engineer, in accordance with Rule 200 of the "Maricopa County Health Department Air Pollution Control Regulations", which require that an Earth Moving Permit be issued and a Control Plan be approved prior to commencement of work. Contact the County at 506-6700 for details.

11. The Contractor shall comply with all applicable Federal Regulations concerning NPDES permits for storm discharges from construction sites.

No additional payment will be made for compliance with the above items.

In addition to the above, the use of new products made with reclaimed material and that meet project specifications, are encouraged.

CLEAN-UP

The Contractor shall, upon completion of the work, remove all temporary construction facilities, debris, and unused materials provided for in the work, and put the work site of the work and public right-of-way in a neat and clean condition. No special payment will be made for this item.

APPROXIMATE QUANTITIES

It is expressly understood and agreed by the parties hereto that the quantities of the various classes of work to be done and material to be furnished under this Contract, which have been estimated, as stated in the Proposal, are only approximate and are to be used solely for the purpose of comparing, on a consistent basis, the proposals offered for the work under this Contract; and the Contractor further agrees that the City of Tempe will not be held responsible if any claim for damages or for loss of profits because of a difference between the quantities of the various classes of work as estimated and the work actually done. If any error, omission, or misstatement is found to occur in the estimated quantities, the same shall not invalidate this Contract or release the Contractor from the execution and completion of the

whole or any part of the work in accordance with the specifications and the plans herein mentioned, and for the prices herein agreed upon and fixed therefore, or excuse him from any of the obligations or liabilities hereunder, or entitle him to any damages or compensation except as may be provided for in this Contract.

MISCELLANEOUS WORK AND ALLOWANCES

The following items will be included in the work with no direct payment allowed. Payment shall be included in the payment for other items for which direct payment is made.

1. Contractor's expenses for but not limited to mobilization, job site office, storage facilities, traffic control and public safety devices, sanitary facilities, utilities and telephone.
2. Cleanup including day to day cleanup.
3. Notification to residents adjacent to this project prior to start of construction which would affect them.
4. Water required for compaction or dust control.
5. Miscellaneous removals and relocations not otherwise specified in the Technical Provisions.
6. Power pole bracing.
7. Removal of trees twelve inches (12") or less in diameter.
8. Removal, relocation and/or modification of existing walls and fences.
9. Trimming of trees and bushes.
10. Replacement of plant material and repair of irrigation equipment to meet or exceed conditions existing prior to Contractor beginning work.

SUPERVISION BY CONTRACTOR

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

PROTECTION OF FINISHED OR PARTIALLY FINISHED WORK

The Contractor shall properly guard and protect all finished or partially finished work, and shall be responsible for the same until that phase is completed and accepted by the City Engineer. Estimate or partial payment of work so completed shall not release the Contractor from such responsibility but he shall turn over the entire work in full accordance with these specifications before final payment can be made.

SURVEY CONTROL POINTS

Existing survey markers (brass caps, hand holes or iron pipes) shall be protected by the Contractor or removed and replaced under the direct supervision of the City Surveyor or his authorized representatives. Lot corners shall not be disturbed without knowledge and consent of the property owner and only after such corner has been properly referenced for replacement.

CONSTRUCTION STAKING

Construction staking will be provided by the City of Tempe or their designated representative in accordance with Section 105.8 of the MAG Specifications unless otherwise provided for in whole or in part in the Special Provisions.

Replacement of construction stakes that have been knocked out due to Contractor's work or lack of work, weather condition, traffic, or vandalism will be at the Contractor's expense.

AUTHORITY OF THE CITY ENGINEER APPOINTED REPRESENTATIVE

The Engineer shall act as the City Engineer's designated representative during the construction period. He shall advise on questions concerning coordination with the City of Tempe, public safety, and quality and acceptability of materials and work performed. The Engineer or his assigned inspector shall interpret the intent of the Contract Plans, Specifications, and Technical Provisions in an unbiased manner. The Engineer or his assigned inspector shall be present on the site at times during construction to monitor the work and to maintain records for contract management. The Engineer shall promptly make decisions relative to the interpretation of the contract document so as to minimize delays in construction. The Engineer will not be responsible for directing construction, control, techniques, sequence, or procedures, or for directing job safety.

SHOP DRAWINGS, SCHEDULES & SAMPLES

In time for each to serve its proper purpose and function, the Contractor shall submit to the Engineer such schedules, reports, drawings, lists, literature samples, instruction, directions, and guarantees as are specified or reasonably required for construction, operation, and maintenance of the facilities to be built and/or furnished under this Contract.

Shop drawings and data shall be submitted to the Engineer in such number of copies as will allow him to retain four (4) copies of each submittal. The submittal shall clearly indicate the specific area of the Contract Documents for which the submittal is made. The additional copies received by him will be returned to the Contractor's representative at the job site. The Engineer's notations of the action which he has taken will be noted on one (1) of these returned copies.

The above drawings, lists, prints, samples, and other data shall become a part of the Contract and a copy of the same shall be kept with the jobsite Contract Documents, and the fabrications furnished shall be in conformance with the same. However, the Engineer's review of the above drawings, lists, prints, specifications, samples, or other data shall in no way release the Contractor from his responsibility for the proper fulfillment of the requirements of this Contract nor for fulfilling the purpose of the installation nor from his liability to replace the same, should it prove defective or fail to meet the specified requirements.

BLUE STAKE

The Contractor is required to notify Blue Stake (263-1100) prior to the excavation of any material in accordance with ARS 40-360.22. The Contractor shall directly contact the City for marking of electrical for traffic signals, sprinkler and irrigation facilities.

SALT RIVER PROJECT CONSTRUCTION CLEARANCE AGREEMENT

Salt River Project requires all contractors who will be working on their facilities to sign a standard form "Construction Clearance Agreement" prior to issuance of a license. This agreement sets forth the requirements to complete the proposed work in an allotted time frame or to pay full costs for others to complete. It also obligates the contractor to comply with all applicable federal, state, and local laws, rules, regulations, and ordinances including, but not limited to, the new OSHA Permit Required Confined Space rules. The contractor is responsible for executing a "Construction Clearance Agreement" with Salt River Project, if required, and furnishing a copy to the City of Tempe prior to proceeding with any construction on Salt River Project facilities.

QUALITY CONTROL

All material shall be new and of the specified quality and equal to the accepted samples, if samples have been submitted. All work shall be done and completed in a thorough, workmanlike manner, notwithstanding any omission from these Contract Documents; and it shall be the duty of the Contractor to call the Engineer's attention to apparent errors or omissions and request instruction before proceeding with the work. The Engineer may, by appropriate instruction, correct errors and supply omissions, which instructions shall be as binding upon the Contractor as though contained in the original contract documents.

At the option of the Engineer, materials to be supplied under this Contract will be tested and/or inspected either at their place of origin or at the site of the work. The Contractor shall give the Engineer written notification well in advance of actual readiness of materials to be tested and/or inspected at point of origin. Satisfactory tests and inspections at the point of origin shall not be construed as a final acceptance of the material nor shall it preclude retesting or reinspection at the site of the work.

CHANGE ORDERS

In the event that significant changes in the scope of the work, and/or changes in the quantities due to contingencies of construction becomes necessary, such changes shall be made in accordance with Section 104 of General Conditions in the MAG 1979 Uniform Standard Specifications.

INSPECTION

The Contractor is responsible for complying with the specifications and is hereby forewarned that final approval of any work will not be given until the entire project is completed and accepted.

NOTIFICATION OF PROPERTY OWNERS

All property owners that may be affected by the proposed construction activities shall be notified of scope and duration of the construction activities by the Contractor prior to start of construction.

ACCESS

Access shall be maintained to adjacent businesses at all times during construction. Where property has more than one point of access, no more than one access shall be restricted or closed at any one time. Access to adjacent private driveways shall be maintained during all non-working hours.

PROTECTION OF EXISTING FACILITIES

The Contractor is to protect all existing facilities during construction. Utility poles that may be affected by the construction activities shall be protected and/or braced by the Contractor. The Contractor shall notify the appropriate Utility Company or agency of any construction that may affect their facilities and state the course of action which will be taken to protect same.

UNDERGROUND UTILITIES

Underground utilities indicated on the plans are in accordance with maps furnished by the City of Tempe and by each utility company. The locations are only approximate and require verification prior to construction as per Tempe requirements for underground street crossings and potholing.

HINDRANCES AND DELAYS

A. Except as provided in paragraph B, no charge shall be made by the Contractor for hindrances or delays from any cause during the progress of any portion of the work embraced in this contract; but such delays, if due to no fault or neglect of the Contractor, shall entitle the Contractor to a time extension sufficient to compensate for the delays. The amount of the delay shall be determined by the Engineer provided the Contractor gives the Engineer immediate notice in writing of the cause of such delay.

B. The parties agree to negotiate for the recovery of damages related to expenses incurred by the Contractor for a delay under the following circumstances:

   1. If the City is solely responsible for the delay which is unreasonable under the circumstances, and

   2. Which delay was not within the contemplation of the parties to the contract at the time the contract was entered into, and

   3. The Contractor can show the impact of the delay on the critical path of the construction activity as indicated in an approved CPM schedule.

The maximum compensation for an unreasonable or unforeseen delay shall not exceed the daily amount specified for liquidated damages as based on the original contract amount.

This section shall not be construed to void any provisions of this contract which require notice of delays, provides for arbitration or other procedure for settlement or provides for liquidated damages.

SUBSIDIARY WORK

All work called for in the specifications and/or shown on the drawings shall be performed by the Contractor and unless a specific bid item is provided for the work, then such portion of the work will be considered subsidiary to other work for which payment is provided.

AS-BUILT DRAWINGS

The Contractor shall provide accurate data and field notes as construction progresses, for preparation of the "As-built" drawings by the Engineer. Final payment for the project will not be given until all such information is submitted.

FINAL ACCEPTANCE & GUARANTEE

"Final Acceptance" shall mean a written final acceptance of the work. The City Engineer shall make the final acceptance promptly after the work has been completed in accordance with the contract documents and after inspection is made. The work performed under this contract shall be guaranteed for a period of one year from the date of final acceptance.

SPECIAL PROVISIONS

A. Add the following sections to the General Provisions:

DEFINITION OF OWNER AND ENGINEER

The term OWNER used in the construction documents refers to the City of Tempe.

The term DESIGN ENGINEER used in the construction documents refers to CH2M HILL.

The term ENGINEER and RESIDENT ENGINEER used in the construction documents refers to PARSONS BRINCKERHOFF CONSTRUCTION SERVICES.

STAGING AREAS

CONTRACTOR shall be responsible for repair or replacement at its own expense of any equipment or materials damaged or destroyed due to flood events or other occurrences within the river, or the staging areas as shown on Drawing B-G-6.

PERMITS

OWNER will obtain and pay only for the following construction permits and licenses:

US COE Section 404 Permit
US EPA National Pollution Discharge Elimination System Permit
Arizona Department of Environmental Quality Water Quality Certification
Arizona Department of Water Resources Dam Safety
Arizona Department of Water Resources Recovery Well Permit
Arizona Department of Transportation Permit
Flood Control District of Maricopa County
City of Tempe Building Permit
Union Pacific Railroad Company
Arizona Public Service
Salt River Project

A copy of each permit is attached in the Appendix. CONTRACTOR shall examine the permits and shall conform to the requirements contained therein, including the purchase of additional Bonds or insurance as specified therein, and such requirements are hereby made a part of these Contract Documents as fully and completely as though the same were set forth herein. Failure to examine the permits will not relieve CONTRACTOR from compliance with the requirements stated therein.

The successful bidder will be required to obtain all other necessary permits and comply with all provisions of said permits. There will be no charge to CONTRACTOR for the necessary City of Tempe permits and inspections.

REPORTS

In preparation of the Drawings and Specifications, DESIGN ENGINEER has prepared the following reports of explorations and tests of subsurface conditions:

1. Report dated December 1994 prepared by CH2M HILL entitled "Geotechnical/ Hydrogeological Data Report for the Rio Salado Town Lake Project."
2. Report dated January 1996 prepared by CH2M HILL entitled "Addendum No. 1 to Geotechnical/Hydrogeological Data Report for the Rio Salado Town Lake Project."
3. Report dated February 1996 prepared by CH2M HILL entitled "Geotechnical/ Hydrogeological Design Report - Rio Salado Town Lake Project."

A copy of these reports are available for review at the office of City of Tempe Engineering during regular business hours.

These reports and drawings are not part of the Contract Documents. CONTRACTOR is not entitled to rely upon other information and data utilized by DESIGN ENGINEER in the preparation of Drawings and Specifications.

OTHER WORK

Other work anticipated to be performed at the site by others prior to, during, and in sequence with the scheduled performance of the Work under these Contract Documents as described in Section 01040, COORDINATION.

Should CONTRACTOR cause damage to the work or property of any separate contractor at the site, or should any claim arising out of or resulting from CONTRACTOR's performance of the Work at the site be made by any separate contractor against CONTRACTOR, OWNER, DESIGN ENGINEER, or RESIDENT ENGINEER or any other person, CONTRACTOR shall promptly attempt to settle with such other contractor by agreement, or to otherwise resolve the dispute by mediation, arbitration, or at law.

CONTRACTOR shall, to the fullest extent permitted by Laws and Regulations, indemnify and hold OWNER, DESIGN ENGINEER, and RESIDENT ENGINEER and the officers, directors, employees, agents, and other consultants of each and any of them harmless from and against all claims, costs, losses and damages, (including, but not limited to, all fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) arising directly, indirectly or consequentially out of or resulting from any action, legal or equitable, brought by a separate contractor against OWNER, DESIGN ENGINEER, or RESIDENT ENGINEER or the officers, directors, employees, agents, or other consultants of each and any of them to the extent based on a claim caused by, arising out of, or resulting from CONTRACTOR's performance of the Work.

Should a separate contractor cause damage to the Work or property of CONTRACTOR or should the performance of work by any separate contractor at the site give rise to any other claim, CONTRACTOR shall not institute any action, legal or equitable, against OWNER, DESIGN ENGINEER, or RESIDENT ENGINEER or the officers, directors, employees, agents, or other consultants of each and any of them or permit any action against any of them to be maintained and continued in its name or for its benefit in any court or before any mediator or arbitrator which seeks to impose liability on or to recover damages from OWNER, DESIGN ENGINEER, or RESIDENT ENGINEER or the officers, directors, employees, agents, or other consultants of each and any of them on account of any such damage or claim.

If CONTRACTOR is delayed at any time in performing or furnishing Work by any act or neglect of a separate contractor and OWNER and CONTRACTOR are unable to agree as to the extent of any adjustment in Contract Times attributable thereto, CONTRACTOR may make a claim for an extension of time. An extension of the Contract Times shall be CONTRACTOR's exclusive remedy with respect to OWNER, DESIGN ENGINEER, or RESIDENT ENGINEER or the officers, directors, employees, agents, or other consultants of each and any of them for any delay, disruption, interference or hindrance caused by any separate contractor. This article does not prevent recovery from OWNER, DESIGN ENGINEER, or RESIDENT ENGINEER or the officers, directors, employees, agents, or other consultants of each and any of them for activities that are their respective responsibilities.

ASBESTOS, PCBs, PETROLEUM, HAZARDOUS WASTE, OR RADIOACTIVE MATERIAL

CONTRACTOR shall not be responsible for any Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material uncovered or revealed at the site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work and which may present a substantial danger to persons or property exposed thereto in connection with the Work at the site. Relevant and applicable regulations of federal, state, and local governments will be used to describe "substantial danger." OWNER will not be responsible for any such materials brought to the site by CONTRACTOR, Subcontractors, Suppliers or anyone else for whom CONTRACTOR is responsible.

CONTRACTOR shall immediately: (i) stop all Work in connection with such hazardous condition and in any area affected thereby (except in an emergency) and (ii) notify OWNER and RESIDENT ENGINEER (and thereafter confirm such notice in writing). OWNER shall promptly consult with RESIDENT ENGINEER concerning the necessity for OWNER to retain a qualified expert to evaluate such hazardous condition or take corrective action, if any. CONTRACTOR shall not be required to resume Work in connection with such hazardous condition or in any such affected area until after OWNER has obtained any required permits related thereto and delivered to CONTRACTOR special written notice: (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (ii) specifying any special conditions under which such Work may be

resumed safely. If OWNER and CONTRACTOR cannot agree as to entitlement to or the amount or extent of an adjustment, if any, in Contract Price or Contract Times as a result of such Work stoppage or such special conditions under which Work is agreed by CONTRACTOR to be resumed, either party may make a claim.

If after receipt of such special written notice CONTRACTOR does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then OWNER may order such portion of the Work that is in connection with such hazardous condition or in such affected area to be deleted from the Work. OWNER may reasonably have such deleted portion of the Work performed by OWNER's own forces or others in order that Work for the full Project is completed in a timely and efficient manner

NO DAMAGE FOR DELAY DUE TO FLOODING

It is understood and agreed that CONTRACTOR has considered in its proposal all the risk due to flooding and unavailability of the Work site associated with working in the Salt River and that no additional compensation will be allowed for any delays or inconvenience due to unavailability of the Work site resulting from flooding or stormwater flow in said river. If delays are encountered due to flooding and unavailability of the Work site due to water in the river, the Contract Time will be adjusted in accordance with Section 108.7 of MAG.

SUBLETTING OF CONTRACT

This section to include all Work performed under this contract, CONTRACTOR/Bidder shall perform with his own organization Work amounting to not less than 60 percent of the total cost. Subcontractor list will be a required submittal. CONTRACTOR shall not sublet, sell, transfer, assign, or otherwise dispose of the contract or contracts, or of his right, title, or interest therein, without written consent of OWNER. Subcontracts shall be in accordance with Paragraph 108.2 of the MAG Specifications.

BIDDER QUALIFICATIONS

Contractor licensed in Arizona having successfully constructed not less than one similar facility in scope, nature, quantity, and cost within the preceding 5 years. Provide references for each project constructed within the past 5 years, including name and contact information. Submit all statements of qualification in a separate package, as attachment to bid forms.

ACTUAL DAMAGES

The Work specified in this Contract embraces an important segment of construction necessary to complete the Rio Salado Town Lake project. Any delay in the completion of this Contract will materially delay the overall completion of the Rio Salado Town Lake project, thereby causing great inconvenience to the public, added cost of engineering and supervision, and other tangible and intangible losses. Therefore, if the Work authorized by this Contract shall remain incomplete after the time specified in the Contract Documents for completion of the Work or after any authorized extension of such stipulated time, the CONTRACTOR shall be liable to the OWNER for the cost of actual damages caused by said

delay. Actual damages shall be determined at time of assessment and shall cover all losses and expenses incurred by the OWNER in conjunction with the failure of the CONTRACTOR to complete the Contract Work on time.

OWNER may withhold from CONTRACTOR the amount of $1,500 per day that the Contract is not completed on schedule (change orders issued will extend original scheduled deadline), as presumptive damages for delay by CONTRACTOR. OWNER shall promptly pay to CONTRACTOR all presumptive damages which exceed actual damages which have been finally determined through the partnering process or the Alternate Dispute Resolution process set forth in this Contract together with 10 percent per annum interest thereon from the date withheld.

Actual damages include, but are not limited to the following items:

1. Damages awarded to other Rio Salado construction contractors resulting from Contract interference or delay caused by the failure of this Contract to be completed on time.

2. Engineering cost associated with delayed contract completion including, but not limited to, inspection, survey layout, materials testing, and contract administration.

3. Loss of anticipated revenues for use of the lake and lake facilities.

4. Other costs that are identified as being directly related to the impact of failure to complete this Contract within the specified Contract time.

5. Cost of financing the Project.

PARTNERING

The foundation and development of a partnering relationship with the CONTRACTOR is a goal of the OWNER. The partnering relationship is to be structured to draw on the strength of each organization and to identify and achieve reciprocal goals. Partnering objectives include efficient and effective contract performance, completion of contract work within budget, on schedule, and in accordance with the Drawings and Specifications.

The partnering relationship shall be bilateral in makeup. An initial formal partnering workshop shall be scheduled after the award of the contract, but prior to the Notice to Proceed. The workshop shall be facilitated by a third party competent in the fundamentals of partnering, who is mutually acceptable to the CONTRACTOR and OWNER. In order to effectively develop the desired partnering relationships, the CONTRACTOR shall encourage attendance by any and all of its project subcontractors. Joint informal partnering meetings, scheduled on 3-month (quarterly) intervals, shall be undertaken throughout the term of the construction contract to strengthen and maintain the initial partnering concepts. The quarterly partnering meetings shall be scheduled to immediately follow the weekly construction progress meeting and shall be at 3-month intervals beginning the third month following the

month in which the construction Notice to Proceed is issued. The agenda of the joint quarterly meetings shall be structured to include review of potential conflicts or upcoming claims, as wall as to review, discuss, and solidify personal relationships between the various participants. Should the OWNER determine that there is need to strengthen the partnering relations, one or more follow-up workshops shall be scheduled. The cost of such workshops shall be shared as set forth in this Specification.

A fundamental aspect of partnering and a key goal of the development of the partnering relationship is dispute resolution in a timely, professional, and nonadversarial manner. In the event that the OWNER determines, in its sole discretion, that a dispute cannot be resolved by this partnering process, the City Engineer shall notify the Neutral Evaluator and all disputes shall be resolved pursuant to the Alternative Dispute Resolution provisions of this contract.

Payment for partnering will be shared equally between the CONTRACTOR and the OWNER. Payment shall include rental costs of the meeting room or other facilities utilized to host the partnering session(s); salary cost of the facilitator, lunch meals for those in attendance, printing, copying, word processing, and other costs incidental to preparing and distributing written materials in preparation of or forthcoming from partnering sessions. Salary cost of participants - except facilitator - is excluded from cost sharing as defined herein.

The CONTRACTOR shall make arrangements for the meeting room and other facilities necessary to conduct the partnering session(s) and shall front all costs including facilitator salary. The OWNER will reimburse the CONTRACTOR for the OWNER's share of partnering costs based on invoices or other documents supporting claimed expenditure. All such documentation shall be subject to review and approval by the OWNER. The OWNER reserves the right to reject, reduce, or otherwise modify claimed cost reimbursement to conform with the cost reimbursement as defined herein.

The CONTRACTOR and OWNER shall submit to the partnering process set forth herein any dispute which arises from the interpretation, work, or directions given under this contract within 5 days that the dispute is or should have been discovered by either party.

ALTERNATIVE DISPUTE RESOLUTION

Scope

Notwithstanding anything to the contrary provided elsewhere in the Contract documents, the alternative dispute resolution (ADR) process provided for herein shall be the exclusive means for resolution of claims or disputes arising under, relating to or touching upon the Contract, the interpretation thereof or the performance or breach by any party thereto, including, but not limited to, original claims or disputes asserted as cross claims, counterclaims, third party claims or claims for indemnity or subrogation, in any threatened or ongoing litigation or arbitration with third parties, if such disputes involve parties to contracts containing this ADR provision.

Neutral Evaluator, Arbitrators

The OWNER has selected High-Point Rendel (Charles Dahill) as a Neutral Evaluator to serve as set forth in this ADR process. The OWNER and CONTRACTOR shall each select an arbitrator of their choice within 15 days of the date of execution of this Contract to serve as set forth in this ADR process. Each arbitrator selected shall be a member of the State Bar of the State of Arizona, and shall be experienced in the field of construction law. Neither the arbitrator nor the arbitrator's firm shall have presently, or in the past, represented any party to the arbitration.

Neutral Evaluation Process

If the parties have been unable to resolve the disputes pursuant to the Partnering Agreement the following neutral evaluation process shall be used to resolve any such disputes:

1. Notification of Dispute: The City Engineer shall promptly notify the Neutral Evaluator in writing of the existence of a dispute.

2. Nonbinding Information Hearing: The Neutral Evaluator shall schedule a nonbinding informal hearing of the matter to be held within 7 days from receipt of notification of the existence of a dispute. The Neutral Evaluator may conduct the hearing in such manner as deems appropriate and shall notify each party to attend the hearing and present evidence they believe will resolve the dispute. The Neutral Evaluator is not bound by the rules of evidence in admitting evidence in the hearing and may limit the length of the hearing, witnesses or evidence introduced to the extent that he deems same to be relevant and efficient. Each party to the dispute shall be notified by the Neutral Evaluator that they shall submit a written outline of the issues and evidence intended to be introduced at the hearing and propose resolution of the dispute to the Neutral Evaluator before the hearing commences. Arbitrators shall not participate in such informal hearing or proceedings process.

3. Nonbinding Decision: The Neutral Evaluator shall render a nonbinding written decision as soon as possible, but not later than 5 days after the hearing.

Binding Arbitration Procedure

If the neutral evaluation procedure is unsuccessful, the following binding arbitration procedure shall serve as the exclusive method to resolve such a dispute. If any party chooses not to accept the decision of the Neutral Evaluator, such party shall notify the Neutral Evaluator in writing within 3 business days of receipt of the Neutral Evaluator's decision of a request for arbitration. The party requesting arbitration shall post a cash bond with the Neutral Evaluator in the amount of $5,000, or a greater amount as determined by the Neutral Evaluator, that will defray the cost of the arbitration as set forth in paragraph 13, Fees and Cost, and the proceeds from said bond shall be allocated in accordance with said paragraph by the Arbitration Panel.

1. Arbitration Panel: The Arbitration Panel shall consist of the arbitrator selected by the parties involved in the dispute, (i.e., OWNER's arbitrator, CONTRACTOR's arbitrator, or any other CONTRACTOR's arbitrator who has a contract with the OWNER which contains this ADR provision and is a party to the dispute), and the foregoing arbitrators shall select a neutral arbitrator as set forth herein. The Neutral Evaluator shall participate in the proceedings and in the deliberations but shall not be entitled to vote.

2. Selection of Neutral Arbitrator: The selected arbitrators shall choose additional arbitrator(s) (one additional arbitrator or two additional arbitrators as needed to ensure that the arbitration panel will consist of an odd number of arbitrators), within 5 days of receipt of notification of a dispute from the Neutral Evaluator. The Neutral Arbitrator(s) shall have the same qualifications as those of the arbitrators set forth in the Neutral Evaluator, Arbitrators paragraph. In the event that the selected arbitrators cannot agree on additional Neutral Arbitrators as set forth above, the Neutral Evaluator shall select the additional arbitrator(s).

3. Expedited Hearing: The parties have structured this procedure with the goal of providing for the prompt and efficient resolution of all disputes falling within the preview of this ADR process. To that end, any party can petition the Neutral Evaluator to set an expedited hearing if circumstances justify it. The Neutral Evalulator shall contact the selected Arbitration Panel and arrange for scheduling of the arbitration at the earliest possible date. In any event, the hearing of any dispute not expedited will commence as soon as practical, but in no event later than 20 days after notification of request for arbitration having been submitted. This deadline can be extended only with the consent of all the parties to the dispute, or by decision of the Arbitration Panel upon a showing of emergency circumstances.

4. Procedure: The Neutral Evaluator shall act as Chairman of the Arbitration Panel and will conduct the hearing that will resolve disputes in a prompt, cost efficient manner giving due regard to the rights of all parties. Each party shall supply to the Arbitration Panel a written prehearing statement which shall contain a brief statement of the nature of the claim or defense, a list of witnesses and exhibits, a brief description of the subject matter of the testimony of each witness who will be called to testify, and an estimate as to the length of time that will be required for the arbitration hearing. The Arbitration Panel may review and consider the Neutral Evaluator's decision. The Chairman shall determine the nature and scope of discovery, if any, and the manner of presentation of relevant evidence consistent with the deadlines provided herein, and the parties' objective that disputes be resolved in a prompt and efficient manner. No discovery may be had of privileged materials or information. The Chairman upon proper application shall issue such orders as may be necessary and permissible under law to protect confidential, proprietary or sensitive materials or information from public disclosure or other

misuse. Any party may make application to the Maricopa County Superior Court to have a protective order entered as may be appropriate to conform to such orders of the Chairman.

5. Hearing Days: To effectuate the parties' goals, the hearing once commenced, will proceed from business day to business day until concluded, absent a showing of emergency circumstances.

6. Award: The Arbitration Panel shall, within 10 days from the conclusion of any hearing, issue its award. The award shall include an allocation of fees and costs pursuant to the Binding Arbitration Procedure paragraph herein. Any award providing for deferred payment shall include interest at the rate of 10 percent per annum. The award is to be rendered in accordance with the Contract and the law of the State of Arizona.

7. Scope of Award: The Arbitration Panel shall be without authority to award punitive damages, and any such punitive damage award shall be void. The Arbitration Panel shall also be without authority to issue an award against any individual party in excess of $2,000,000, exclusive of interest, arbitration fees, costs, and attorney's fees. If an award is made against any individual party in excess of $100,000, exclusive of interest, arbitration fees, costs, and attorneys' fees, it must be supported by written findings of fact, conclusions of law and statement as to how damages were calculated.

8. Jurisdiction: The Arbitration Panel shall not be bound for jurisdictional purposes by the amount asserted in any party's claim, but shall conduct a preliminary hearing into the question of jurisdiction upon application of any party at the earliest convenient time, but not later than the commencement of the arbitration hearing.

9. Entry of Judgment: Any party can make application to the Maricopa County Superior Court for confirmation of any award and for entry of judgment on it.

10. Severance and Joinder: To reduce the possibility of inconsistent adjudications, the Neutral Evaluator or the Arbitration Panel, may at the request of any party, join and/or sever parties, and/or claims arising under other contracts containing this ADR provision, and the Neutral Evaluator, (Chairman) may, on his own authority, join or sever parties and/or claims subject to this ADR process as they deem necessary for a just resolution of the dispute, consistent with the parties' goal of the prompt and efficient resolution of disputes. Nothing herein shall create the right by any party to assert claims against another party not recognized under the substantive law applicable to the dispute. Neither the Neutral Evaluator or the Arbitration Panel are authorized to join to the proceeding parties not in privity

of General and Special Conditions to this Construction Contract.

17. Merger and Bar: Any claim asserted pursuant to this ADR process shall be deemed to include all claims, demands, and requests for compensation for costs and losses or other relief, including the extension of Contract Time which reasonably should or could have been brought against any party that was or could have been brought into this ADR process. The Arbitration Panel shall apply legal principles commonly known as merger and bar to deny any claim or claims against any party regarding which claim or claims recovery has been sought or should have been sought in a previously adjudicated claim for an alleged cost, loss, breach, error, or omission

B. Modify the following sections within the General Provisions:

SPECIFICATIONS

Replace the first paragraph of this section within the General Provisions with the following:

All Work done under this contract shall be accomplished in accordance with these Project Specifications supplemented by the Maricopa Association of Governments (MAG) Uniform Standard Specifications and Standard Details for Public Works Construction and the City of Tempe Supplement, including 1995 revisions.

INSURANCE REQUIREMENTS

Add the following to this section within the General Provisions:

Include the following as additional insureds:

OWNER: City of Tempe
DESIGN ENGINEER: CH2M HILL
RESIDENT ENGINEER: PARSONS BRINCKERHOFF CONSTRUCTION SERVICES

INDEMNITY

Replace the first paragraph under this section in the General Provisions with the following:

To the fullest extent permitted by laws and regulation, CONTRACTOR shall indemnify and hold harmless OWNER, DESIGN ENGINEER, RESIDENT ENGINEER, their employees and agents from and against all losses and expenses, direct, indirect, or consequential, and all claims, demands, payments, suits, actions, recoveries, and judgments of every nature and description brought or recovered against them by any reason of any act, omission, negligence, or claimed negligence of OWNER, DESIGN ENGINEER, RESIDENT ENGINEER, their employees and agents, other than for loss or damage resulting from the sole negligence of the

OWNER, DESIGN ENGINEER, RESIDENT ENGINEER, their employees, and agents, arising from the Work, completed Work, or product under this contract.

CONTRACTOR'S CONSTRUCTION SCHEDULE

Delete this section in the General Provisions and refer to Section 01310, PROGRESS SCHEDULES.

MISCELLANEOUS WORK AND ALLOWANCES

Replace Item No. 1 of this section in the General Provisions with the following:

1. CONTRACTOR's expenses for, but not limited to, mobilization, jobsite office, storage facilities, traffic control and public safety devices, sanitary facilities, utilities, and telephone, unless specifically allowed in the Contract Documents.

SHOP DRAWINGS, SCHEDULES, AND SAMPLES

Delete the second paragraph of this section in the General Provisions and refer to Section 01300, SUBMITTALS.

QUALITY CONTROL

Add the following to this section within the General Provisions:

Tests required by Contract Documents to be performed by CONTRACTOR and that require test certificates be submitted to OWNER or RESIDENT ENGINEER for acceptance shall be made by an independent testing laboratory or agency licensed or certified in accordance with Laws and Regulations and applicable state and local statutes. In the event state license or certification is not required, testing laboratories or agencies shall meet the following applicable requirements:

1. "Recommended Requirements for Independent Laboratory Qualification" published by the American Council of Independent Laboratories.
2. Basic requirements of ASTM E329, "Standard of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction" as applicable.
3. Calibrate testing equipment at reasonable intervals by devices of accuracy traceable to either the National Bureau of Standards or accepted values of natural physical constants.

FINAL ACCEPTANCE & GUARANTEE

Add the following:

Prior to requesting a certificate of final acceptance, and allowing occupancy of the facilities, CONTRACTOR shall provide an inspection by a state industrial representative or a federal or state (OSHA) representative qualified in the construction type being inspected, to determine that the facilities provided are in compliance with

the state and federal safety requirements. Signed copies of the inspection reports shall be submitted to RESIDENT ENGINEER for OWNER's files. Violations or deficiencies noted therein shall be resolved by CONTRACTOR prior to occupancy of the facilities and before final payment will be made.

CITY OF TEMPE

TEMPE, ARIZONA

TECHNICAL SPECIFICATIONS

for the construction of the

RIO SALADO TOWN LAKE

PROJECT NO. 946523-B

SCHEDULE B - DAM FACILITIES

****

Registered Professional Engineer (Civil)
CERTIFICATE NO. 21226
CHARLES A. PEDRI
Date Signed 11/6/96
ARIZONA, U.S.A.

Registered Professional Engineer (Structural)
CERTIFICATE NO. 29861
ROBERT L. MORRISON SR.
Date Signed 11/5/96
ARIZONA U.S.A.

****

CH2M HILL

Tempe, Arizona

November 1996

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Project No. 111253.09

Copy No._____

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APPENDIX

DRAWINGS (BOUND SEPARATELY)

END OF SECTION

SECTION 01010
SUMMARY OF WORK

PART 1 GENERAL

1.1 RIO SALADO TOWN LAKE PROJECT

A. The City of Tempe, Arizona's, Rio Salado Town Lake Project is an urban redevelopment project focused on the construction of a 200-acre recreational lake in the normally dry Salt River bed. Water flows in the river channel in response to flood events. Water may also occur in the river due to localized storm events or incidental releases into the storm drain system.

B. The 2-mile long lake will be formed by impounding water using air-inflatable rubber dams. The depth of the lake will vary from 6 feet at the upstream end to 19 feet at the downstream end. During seasonal flooding, the dams will be lowered to allow flood waters to pass downstream. When flooding stops, the dams will be raised to impound water for the lake once again. When fully deflated, the dams must pass the 100-year peak flood flows of 215,000 cfs and must also pass the peak sediment volume of 230,000 tons per day during the 100-year event. It is expected that the dam will be fully deflated during about 10 percent of the flood events.

C. The downstream dam will consist of a 16-foot high rubber dam on a 3-foot high sill and will control the water level in the lake. A smaller 6-foot high dam at the upstream end will capture local river discharges, creating a wetlands-type riparian enhancement zone while reducing the flow of pollutants into the lake.

D. Infiltration from the lake will be controlled by a combination of cutoff walls and controlled extraction/recovery wells. Infiltration from the downstream (western) portion of the lake will be controlled using cutoff walls along the lake boundary. Approximately 10 recovery wells will be used along the upstream (eastern) portion to collect and pump back to the lake an estimated 40 million gallons per day of infiltrated water.

E. A reliable source of water is required as makeup water for losses due to evaporation. Facilities provided include new connections to the Salt River Project canal system for delivery to the lake. Water for the initial filling of the lake and for monitoring the lake water level will be conveyed through a new 48-inch pipeline. This pipeline provides a connection between the existing SRP Lateral 2-4.6 and the existing 66-inch storm drain which empties into the lake.

F. A stormwater management system will be constructed to improve the water quality in the lake by reducing the inflow of potential pollutants and contaminants. Stormwater diversions will capture and bypass the "first flush" from several major stormwater discharges to a point either upstream or downstream of the lake. In addition, detention areas will be provided to

reduce the potential for spills from the Red Mountain Freeway entering the lake.

G. The Rio Salado Town Lake Project is divided into the following four schedules:

1. Schedule A: Pipe and Well Systems.
2. Schedule B: Dam Facilities.
3. Schedule C: Shoreline Improvements.
4. Schedule D: Cutoff Wall Construction.

1.2 WORK COVERED BY THESE CONTRACT DOCUMENTS (SCHEDULE B):

A. The completed Work covered by these Contract Documents will provide OWNER with:

1. The downstream dam consisting of a concrete foundation, piers, abutments, apron, and four 16-foot high rubber dams for the purpose of impounding the Town Lake.
2. The upstream dam consisting of a concrete foundation, piers, abutments, apron, and four 5-foot high rubber dams required to define the eastern limit of the lake.
3. A rubber dam control building including the required utilities and control system at both the upstream dam and downstream dam.
4. A recycle pump station located in the north abutment of the downstream dam.
5. A temporary cofferdam system.
6. Modification to railroad bridge piers.

B. Alternatives specified in the Contract Documents are as follows:

1. Deductive Alternate No. B1: Upstream rubber dam, foundation, piers apron, and operations building. This deductive alternate will include all facilities related to the upstream dam including the rubber dam, foundation, piers, aprons, operations buildings, water supply line, and power supply.
2. Deductive Alternate No. B2: Coffer dam pile. This deductive alternate includes the soldier piles and panels for the coffer dam for both the upstream and downstream dam. The imbedded materials and pile socket caps are not part of the deductive alternate.

1.3 OWNER-FURNISHED EQUIPMENT

A. The following equipment will be furnished by OWNER in accordance with the documents entitled "Rubber Dams for Town Lake," issued by the City of Tempe, Arizona; Request for Proposal 96-073 and applicable addendas to be incorporated or installed in the Work by CONTRACTOR. Unless indicated otherwise, items will be furnished F.O.B. the site. Product Information is available in Section 11581, RUBBER DAMS.

B. Installation is specified in Section 13005, INSTALLATION OF OWNER-FURNISHED PRODUCTS.

C. OWNER will keep CONTRACTOR informed of the probable delivery dates and will give timely confirmation of final delivery.

D. OWNER's Responsibilities:

1. Arrange for and deliver OWNER-reviewed Shop Drawings, product data, and Samples to CONTRACTOR.
2. Confirm delivery date with CONTRACTOR 21 days prior to scheduled delivery.
3. Arrange and pay for delivery to site.
4. Provide CONTRACTOR with storage, protection, and unloading instructions.
5. On delivery, inspect jointly with CONTRACTOR.
6. Submit claims for transportation damage and replace damaged, *defective*, or deficient items.
7. Arrange for manufacturer's invoice and warranties.

E. CONTRACTOR's Responsibilities:

1. Review OWNER-reviewed Shop Drawings, product data, and Samples.
2. Receive and unload products at site; inspect for completeness or damage, jointly with OWNER. Provide all labor and equipment for unloading.
3. Handle, store, and maintain products as recommended by OWNER.
4. Repair or replace items damaged after receipt.
5. Indicate signed acceptance of delivery on a copy of the invoice.
6. Install, connect, test, and startup in accordance with manufacturer's instructions unless otherwise specified.
7. Maintain inventory of products.
8. Scheduling the training of OWNER personnel.
9. Scheduling site visits for manufacturer representatives.

1.4 WORK NOT COVERED BY THESE CONTRACT DOCUMENTS

A. Schedule A: Pipe and Well Systems.

B. Schedule C: Shoreline Improvements.

C. Schedule D: Cutoff Wall Construction.

1.5 PROVISIONS FOR FUTURE WORK

A. Provisions for future construction are as shown.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01025
MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.1 ADMINISTRATIVE SUBMITTALS

A. Schedule of Values: Submit schedule on CONTRACTOR's standard form.

B. Application for Payment.

C. Final Application for Payment.

1.2 SCHEDULE OF VALUES

A. Prepare a separate schedule of values for each schedule of Work under the Agreement.

B. Lump Sum Work:

1. Reflect schedule of values format included in conformed Bid Form, specified allowances, alternates, and equipment selected by OWNER, as applicable.
2. List Bonds and insurance premiums, mobilization, demobilization, facility startup, and contract closeout separately.
3. Break down by Division 2 through 16 with appropriate subdivision of each Specification for each of the Project facilities.

C. Unit Price Work: Reflect unit price quantity and price breakdown from conformed Bid Form.

D. Each pay item reflecting a schedule of values shall be subject to a review and approval of RESIDENT ENGINEER. An unbalanced or front-end loaded schedule will not be acceptable.

E. Summation of the complete schedule of values representing all Work shall equal the Contract Price.

F. Submit schedule of values on 3.5-inch, 1.44mb diskettes, in a spreadsheet format compatible with the latest version of Excel.

1.3 APPLICATION FOR PAYMENT

A. RESIDENT ENGINEER shall prepare both monthly and final contract progress payments and submit to OWNER for approval. Payment shall be based on data received from CONTRACTOR, subject to evaluation and concurrence of RESIDENT ENGINEER.

B. CONTRACTOR shall transmit application for payment to RESIDENT ENGINEER on a draft Application for Payment Form provided by OWNER.

C. Attach one Schedule of Value form with each draft application for payment for each lump sum item of Work and include a request for payment of materials and equipment on hand as applicable. Execute certification by authorized officer of CONTRACTOR.

D. Preparation:

1. Round values to nearest dollar.
2. List each Change Order and Written Amendment executed prior to date of submission as separate line item. Totals to equal those shown on the Transmittal Summary Form for each schedule as applicable.
3. Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form(s) for each schedule as applicable, a listing of materials on hand for each schedule as applicable, and such supporting data as may be requested by RESIDENT ENGINEER.

1.4 MEASUREMENT – GENERAL

A. Weighing, measuring, and metering devices used to measure quantity of materials for Work shall be suitable for purpose intended and conform to tolerances and specifications as specified in National Institute of Standards and Technology, Handbook 44.

B. Whenever pay quantities of material are determined by weight, the material shall be weighed on scales furnished by CONTRACTOR and certified accurate by the state agency responsible. A weight or load slip shall be obtained from the weigher and delivered to RESIDENT ENGINEER at the point of delivery of the material.

C. If material is shipped by rail, the car weights will be accepted provided that actual weight of material only will be paid for and not minimum car weight used for assessing freight tariff, and provided further that car weights will not be acceptable for material to be passed through mixing plants.

D. Vehicles used to haul material being paid for by weight shall be weighed empty daily and at such additional times as required by RESIDENT ENGINEER. Each vehicle shall bear a plainly legible identification mark.

E. Quantities Based on Profile Elevations: Existing ground profiles shown on Drawings were taken from a topographic map drawn with contour intervals of 1 foot with supplementary spot elevations to the nearest half foot.

F. Quantities will be based on ground profiles shown. Field surveys may be made by OWNER to confirm accuracy of elevations shown.

G. Units of measure shown on the Bid Form shall be as follows unless specified otherwise.

Item	Method of Measurement
CY	Cubic Yard–Field Measure by ENGINEER within the limits specified or shown
EA	Each–Field Count by ENGINEER
HR	Hour
LF	Linear Foot–Field Measure by ENGINEER
LS	Lump Sum–Unit is one; no measurement will be made
SF	Square Foot
SY	Square Yard
SAC	Sack of Cement

1.5 PAYMENT

A. General: Progress payments will be made monthly on the date established at the preconstruction meeting.

B. Payment for Lump Sum Work covers all Work specified or shown within the limits or Specifications, or as described as follows:

1. Item No. 1, Mobilization/Demobilization for Dam Facilities Work Demolition, and Diversion and Care of Water: CONTRACTOR shall be compensated for one-time mobilization/demobilization of CONTRACTOR's personnel,, equipment, supplies, incidentals, establishment of offices, building and other facilities required for the performance of the Work under this contract. Also included in this item is all Work required for the diversion and care of water and demolition of existing facilities, and all Work for the Project with the exception of those items specifically listed as either lump sum or unit price items. Payment for mobilization/demobilization will be made at the contract lump sum price shown in the Bid Schedule for Bid Item 1, Mobilization/Demobilization. Payment shall be made in equal one-third portions. The first one-third shall be paid with CONTRACTOR's first monthly progress payment. The second one-third shall be paid when the total payment to CONTRACTOR for the bid items under this contract, exclusive of payment for mobilization/demobilization, equals one-half of the total bid amount. The remaining one-third shall be paid as part of the final contract payment due CONTRACTOR. If CONTRACTOR performs a second mobilization/demobilization of personnel, material, and/or equipment at the ENGINEER's expressed written request, CONTRACTOR shall be compensated for such expense at CONTRACTOR's actual cost. CONTRACTOR shall provide all documentation requested by ENGINEER in support of said cost.

2. Item No. 2, Downstream Dam Foundation, Piers, Abutments, and Apron: Includes all labor and equipment required for excavation, roller compacted concrete, furnishing and placing of formwork,

concrete, reinforcing steel, anchor dowels, concrete curing, joint sealants, finishes, aeration piping, drain piping, electrical conduit, riprap, concrete cutoff wall, bar screen, wrought iron fencing, security lighting, gabion removal and replacement, hatches, grating, ladders, flap gate and frame, pile sockets and caps, recycle pumps, pump suction and outlet piping, valves, and appurtenances, sluice gate, backfill, grading, and all other miscellaneous items required to complete the downstream dam foundation, piers, abutments, and apron as shown on the Drawings.

3. Item No. 3, Downstream Dam Operations Building: Includes all labor and equipment required for excavation, backfill, grading, furnishing and placing of formwork, concrete, reinforcing steel, anchor dowels, concrete curing, grout, joint sealants, finishes, ventilation and cooling system, water piping, aeration piping, pressure sensing piping, electrical conduit, acoustical screens, roof trellis, masonry, steel decking, roofing, louvers, doors, hardware, lighting, television surveillance equipment, electrical supply and instrumentation and control systems, and all other miscellaneous items required to complete the downstream dam operations building as shown on the Drawings.
4. Item No. 4, Installation of OWNER-Furnished Downstream Rubber Dams and Blowers: Includes all labor and equipment required for the storing, handling, installing, adjusting, maintaining, lubricating, testing, and operational startup of the four rubber dam bladders, embedded materials, clamping materials, anchor bolts, air supply blowers, pressure sensors, water level gauges, valves, electrical control panel, and all other miscellaneous items required to install complete the downstream rubber dams and blowers as shown on the Drawings.
5. Item No. 6, Upstream Dam Foundation, Piers, Abutments, and Apron: Includes all labor and equipment required for excavation, furnishing and placing of formwork, concrete, reinforcing steel, anchor dowels, concrete curing, grout, joint sealants, finishes, electrical conduit, concrete cutoff walls, wrought iron fencing, security lighting, television surveillance camera, gabion removal and replacement, flap gate and frame, coffer dam sockets and caps, backfill, grading, and all other miscellaneous items required to complete the upstream dam foundation, piers, abutments, and apron as shown on the Drawings.
6. Item No. 7, Upstream Dam Operations Building: Includes all labor and equipment required for excavation, backfill, grading, furnishing and placing of formwork, concrete, reinforcing steel, anchor dowels, concrete curing, grout, joint sealants, finishes, relocation of existing fencing, ventilation and cooling system, water piping, pressure sensing piping, electrical conduit, acoustical screens, masonry, steel decking, roofing, louvers, doors, hardware, electrical and instrumentation and control systems, and all other miscellaneous items required to complete the upstream dam operations building as shown on the Drawings.
7. Item No. 8, Installation of OWNER-Furnished Upstream Rubber Dams and Blowers: Includes all labor and equipment required for the storing, handling, installing, adjusting, maintaining, lubricating, testing, and operational startup of the four rubber dam bladders,

embedded materials, clamping materials, anchor bolts, air supply blowers, pressure sensors, water level gauges, valves, electrical control panel, and all other miscellaneous items required to install complete the upstream rubber dams and blowers as shown on the Drawings.

8. Item No. 9, Union Pacific Railroad Bridge Modifications: Includes all labor, equipment, and materials required for furnishing and placing form work, concrete, reinforcing steel, anchor dowels, concrete curing, waterstops, and all other miscellaneous items required to complete the modifications to the Southern Pacific Transportation Company Bridge as shown on the Drawings.
9. Item No. 19, Coffer Dam: Includes all labor, equipment, and materials required for the fabrication of the coffer dam panels and soldier piles and all other miscellaneous items required to complete the coffer dam panels and soldier piles.

C. Payment for unit price items covers all Work necessary to furnish and install the following items:

1. Item No. 5, Submersible Pumps and Motors. As described in Section 11305, SUBMERSIBLE PUMPS. Payment will be made at the contract unit price bid for each type of completed installation of pump and motor.
2. Item No. 10, Drilling and Grouting: Includes all labor, equipment, and materials required for installing anchor bars, drilling grout holes, compaction grouting contact grouting, and all associated Work. Payment will be made at the contract unit price bid per sack of cement for grout placed.
3. Item No. 11, Removal of Unsuitable Materials: In the event unsuitable material is encountered during the Project, it shall be removed and disposed of offsite. Includes the additional excavation, disposal, grading, benching, borrow material, backfill, and compaction as required to dispose of the unsuitable material and construct an engineered fill from the bottom of the excavation to the design grade with trench stabilization material. Measurement for this Work shall be made on a volumetric basis by the end area cross-section method. Measurement for excavation will be made from the top of the unsuitable material encountered to the bottom of the excavation.
4. Items No. 12 and 13, Electrical Conduit for Primary Service: Includes all labor equipment and materials for site preparation, excavation, processing of onsite material or importation of material required for placement of pipe bedding, pipe zone, and backfill, providing conduit for primary service, fittings, spacers, concrete encasement, removal and replacement of gabions, surfacing, and all associated Work. Payment will be made at the contract unit price bid per linear foot for the completed installation of electrical conduit. All other electrical conduit is included in Items No. 3 and 7.
5. Item No. 14, Installation of Communications Conduits Furnished by Others: Includes all labor, equipment, and materials required for placement of conduit in the dam foundation which will be furnished by Cox Cable.

6. Item No. 15, Transformer Pads: Includes all labor, equipment, and materials for site preparation, excavation, furnishing and placement of concrete, reinforcement, and all associated Work required to complete each transformer pad. Payment will be made at the contract unit price bid for completed installation of each transformer pad.
7. Item No. 16, Control Cabinets and Pads: Includes all labor, equipment, and materials required for site preparation, excavation, furnishing and placement of concrete, reinforcement, control cabinets, and all associated Work required to furnish and install complete each control cabinet and pad. Payment will be made at the contract unit price bid for completed installation of each control cabinet and pad.
8. Item No. 17, Installation of APS Furnished Pullboxes: Includes all labor, equipment, and materials for site preparation, excavation, backfill, and all associated Work required to complete each pullbox. Payment will be made at the contract unit price bid for the completed installation of each electrical pullbox.
9. Item No. 18, Installation of APS Furnished Electrical Equipment Pad/Box Pad: Includes all labor, equipment, and materials for site preparation, excavation, and all associated Work required to complete each electrical box pad. Payment will be made at the contract unit price bid for completed installation of each electrical box pad for the switching cabinets and capacitor cabinets.

1.6 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

A. Payment will not be made for following:

1. Loading, hauling, and disposing of rejected material.
2. Quantities of material wasted or disposed of in manner not called for under Contract Documents.
3. Rejected loads of material, including material rejected after it has been placed by reason of failure of CONTRACTOR to conform to provisions of Contract Documents.
4. Material not unloaded from transporting vehicle.
5. *Defective* Work not accepted by OWNER.
6. Material remaining on hand after completion of Work.

1.7 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Partial Payment: No partial payments will be made for materials and equipment delivered or stored unless Shop Drawings or preliminary operation and maintenance manuals are acceptable to ENGINEER.

B. Final Payment: Will be made only for products incorporated in Work; remaining products, for which partial payments have been made, shall revert to CONTRACTOR unless otherwise agreed, and partial payments made for those items will be deducted from final payment.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01040
COORDINATION

PART 1 GENERAL

1.1 SUBMITTALS

A. Statement of Qualification (SOQ) for land surveyor or civil engineer.

B. Photographs and other records of examination.

1.2 PARTNERING

A. The OWNER and the CONTRACTOR will have a partnering relationship as described in the Special Provisions. In addition, other utilities, agencies, and contractors will be included in the partnering process.

1.3 OTHER WORK

A. Coordination of OWNER's Work by Others: Reference the General Conditions for coordination of OWNER's work by others, if any, and coordinate CONTRACTOR's Work with OWNER or OWNER's designated coordinator.

B. Other work is anticipated to be performed at site by others prior to, during, and in sequence with scheduled performance of Work under these Contract Documents as follows:

C. Public Utilities and Agencies:

1. Power:
   a. Agency and Contact Person: Arizona Public Service, Vicki Reynolds, telephone number: 602/493-4433.
   b. Work to be performed by APS:
      1) Incoming underground power cables, materials, installation, termination, and connections to all facilities.
      2) Transformer supplying main electric service to the facility.
      3) Primary switching cabinets.
      4) Metering facilities, except as indicated.

   c. Work to be performed by CONTRACTOR:
      1) Coordinate CONTRACTOR's Work with APS.
      2) Incoming power trench, and backfill, and duct system.
      3) Transformer site preparation and pad(s).
      4) Installation of utility-furnished pullboxes and box pads.
      5) As indicated.
      6) Obtain all relevant design documents, instructions, standards, specifications, drawings, and details from APS.
   d. OWNER will be responsible for payment of direct charges of APS.

2. Cable TV:
   a. Agency and Contact Person: Cox Cable, Randy Rollard, telephone number: 602/866-0072, Ext. 582.
   b. Work to be Performed by Cox Cable: Furnish conduits to be installed in dam foundations.
   c. Work to be Performed by CONTRACTOR: Installation of utility-furnished conduit.

D. Agencies:

1. Flood Control District of Marciopa County (FCDMC):
   a. OWNER will obtain a license from the FCDMC prior to any work which impacts the levees or other flood control features.
   b. OWNER will notify the FCDMC at least 48 hours prior to any construction activities which require disturbing the levee CSA or gabions. This will allow the FCDMC inspector to be onsite for inspection purposes.
   c. OWNER will not backfill over any levee gabions that may be disturbed as part of construction without first having the gabions inspected by the FCDMC. Any damage to the gabions shall be repaired by CONTRACTOR to the satisfaction of the FCDMC.
   d. OWNER will not place backfill or concrete against the levee CSA without first having the CSA inspected by the FCDMC. Any damage to the CSA shall be repaired by CONTRACTOR to the satisfaction of the FCDMC.
   e. CONTRACTOR shall allow inspection by FCDMC representatives for the activities specified below.

2. Department of Water Resources (DWR):
   a. OWNER will obtain a license to operate the dam from DWR prior to filling of the lake.
   b. CONTRACTOR shall allow inspection by DWR Dam Safety representative to all activities related to this Project.
   c. OWNER will notify DWR at least 48 hours prior to any construction activities requiring their inspection and approval.

E. Other Contractors:

1. Schedule A: Pipe and Well Systems (contractor unknown).
   a. Stormdrain system.
   b. Wells and associated piping.
   c. Source water supply.
2. Schedule C: Shoreline Improvements (contractor unknown).
   a. Northshore and shoreline improvements.
   b. Southshore shoreline improvements.
3. Schedule D: Cutoff Wall Construction (contractor unknown).
   a. Northshore cutoff wall.
   b. Southshore cutoff wall.
   c. Downstream dam cutoff wall.
4. North Bank Bike Path (contractor unknown).
   a. Bike path between SPTC railroad bridge and Rural Road on northshore.

5. Schedule A Pipe and Well Systems, Schedule C Shoreline Improvements, and Schedule D Cutoff Wall Construction will receive the same Notice to Proceed dates. Schedule B Dam Facilities will receive a Notice to Proceed date approximately 5 months later.
6. Work to be performed by CONTRACTOR:
   a. Coordinate CONTRACTOR's Work with work of other contractor, particularly at the following locations:
      1) Outfall of southbank interceptor is in immediate proximity to the downstream dam.
      2) Outfall of Dorsey Diversion and Recovery Wells No. 5 and No. 6 are in immediate proximity to the upstream dam.
      3) Well No. 5 is in immediate proximity to upstream dam control building.

1.4 UTILITIES

A. Coordinate Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during Work.

1. Salt River Project Electricity Company:
   a. Contact Person: Jim Frescholtz.
   b. Telephone: 602/236-8476.
2. U.S. West Telephone Company:
   a. Contact Person: Bruce Bartlett.
   b. Telephone: 602/831-4753.
3. City of Tempe Water Department:
   a. Contact Person: Don Hawkes.
   b. Telephone: 602/350-2660.
4. City of Tempe Public Works Department:
   a. Contact Person: Howard Hargis.
   b. Telephone: 602/350-8200.
5. Telephone Company: AT&T.
   a. Contact Person: Blue Stake.
   b. Telephone: 602/263-1100, or
   c. Contact Person: Cable Hazard Center.
   d. Telephone: 1-800-252-1133.
6. Telephone Company: MCI
   a. Contact Person: Blue Stake.
   b. Telephone: 602/263-1100, or
   c. Contact Person: Fiber Security Department.
   d. Telephone: 1-800-782-5348.
7. Gas Company: Southwest Gas.
   a. Contact Person: Howard Warren.
   b. Telephone: 602/484-5235 or 602/271-4277.
8. Water Department: City of Phoenix Water Department:
   a. Contact Person: 24-hour Emergency.
   b. Telephone: 602/261-8000.
9. Nitrogen Company: Air Products.
   a. Contact Person: Paul Sansoucy.
   b. Telephone: 602/899-7700.
10. Electricity Company: Arizona Public Service.
   a. Contact Person: Vicki Reynolds.

b. Telephone: 602/493-4433.

11. Flood Control: Flood Control District of Maricopa County.
    a. Contact Person: Fred Fuller.
    b. Telephone: 602/506-1501 or 602/506-4728.
12. Cable TV Company: Cox Cable.
    a. Contact Person: Shawn Hawkins.
    b. Telephone: 602/352-5860, Extension 159.

B. Railroad(s) serving the area at or near site:

1. Railroad: Union Pacific Railroad.
    a. Office Address: Denver, CO.

1.5 PROJECT MEETINGS

A. General:

1. RESIDENT ENGINEER: Schedule physical arrangements for meetings throughout progress of Work, prepare meeting agenda with OWNER and CONTRACTOR input and distribute with written notice of each meeting, preside at meetings, record minutes to include significant proceedings and decisions, and reproduce and distribute copies of minutes within 5 days after each meeting to participants and parties affected by meeting decisions.
2. Representatives of OWNER, CONTRACTOR, and Subcontractors shall attend meetings, as needed.

B. Preconstruction Conference:

1. CONTRACTOR shall be prepared to discuss the following subjects, as a minimum:
    a. Required schedules.
    b. Status of Bonds and insurance.
    c. Sequencing of critical path work items.
    d. Project changes and clarification procedures.
    e. Use of site, access, office and storage areas, security and temporary facilities.
    f. Major product delivery and priorities.
    g. CONTRACTOR's safety plan and representative.
2. Attendees may include but not be limited to:
    a. OWNER's representatives.
    b. CONTRACTOR's office representative.
    c. CONTRACTOR's resident superintendent.
    d. CONTRACTOR's quality control representative.
    e. Subcontractors' representatives whom CONTRACTOR may desire or RESIDENT ENGINEER may request to attend.
    f. RESIDENT ENGINEER's representatives.
    g. Others as appropriate.
    h. Progress payment procedures.

C. Preliminary Schedules Acceptability Review Meeting: As set forth in the General Conditions.

D. Progress Meetings:

1. RESIDENT ENGINEER will schedule regular progress meetings at site, conducted weekly to review Work progress, progress schedule, Shop Drawing and Sample submissions schedule, Application for Payment, contract modifications, and other matters needing discussion and resolution.
2. Attendees will include:
   a. OWNER's representative(s), as appropriate.
   b. CONTRACTOR, Subcontractors, and Suppliers, as appropriate.
   c. RESIDENT ENGINEER's representative(s).
   d. Flood Control District's representative(s).
   e. Others as appropriate.

E. Quality Control and Coordination Meeting(s):

1. Scheduled by RESIDENT ENGINEER on regular basis and as necessary to review test and inspection reports, and other matters relating to quality control of Work and work of other contractors.
2. Attendees will include CONTRACTOR, CONTRACTOR's designated quality control representative, selected Subcontractors and Suppliers, contractors responsible for other construction schedules, and RESIDENT ENGINEER's representatives.

F. Preinstallation Meetings:

1. When required in individual Specification sections, convene at site prior to commencing Work of that section.
2. Require attendance of entities directly affecting, or affected by, Work of that section.
3. Notify RESIDENT ENGINEER 4 days in advance of meeting date.
4. Provide suggested agenda to RESIDENT ENGINEER to include reviewing conditions of installation, preparation and installation or application procedures, and coordination with related Work and work of others.

G. Other Meetings: In accordance with Contract Documents and as may be required by OWNER and RESIDENT ENGINEER.

1.6 SEQUENCE OF WORK

A. Certain work, sequence, order, and direction is specified in Section 01310, PROGRESS SCHEDULES, Article SCHEDULE RESPONSIBILITIES. Compliance with this section is required to integrate the multiple construction activities scheduled to occur in this area. CONTRACTOR's construction schedule must conform to the requirements set forth in Section 01310, PROGRESS SCHEDULES, Article SCHEDULE RESPONSIBILITIES and the master Rio Salado Town Lake schedule shown in Exhibit A to Section 01310.

B. Construct Work in stages to allow for OWNER's uninterrupted operation during construction. Coordinate construction schedule and operation with the OWNER.

C. Be responsible for bypass facilities and temporary connections required to maintain OWNER's operations. Sequences other than those specified will be considered by RESIDENT ENGINEER, provided they afford equivalent continuity of operations.

D. Power outages will be considered upon 48 hours written request to OWNER and RESIDENT ENGINEER. Describe the reason, anticipated length of time, and areas affected by the outage in its written request. Provide temporary provisions for continuous power supply to critical existing facility components if requested by OWNER and RESIDENT ENGINEER.

E. Perform Work continuously during critical connections and changeovers, and as required to prevent interruption of OWNER's operations.

F. Coordinate proposed Work with the RESIDENT ENGINEER and facility operations personnel before effecting unit shutdowns. Under no circumstances cease Work at the end of a normal working day if such actions may inadvertently cause a cessation of any facility operating process, in which case, remain onsite until necessary repairs are complete.

G. Do not close lines, open valves, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after approval of OWNER and RESIDENT ENGINEER. Such actions will be considered by OWNER and RESIDENT ENGINEER upon 48 hours written notice to RESIDENT ENGINEER.

1.7 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

1. After Effective Date of the Agreement and before Work at site is started, CONTRACTOR, RESIDENT ENGINEER, and affected property owners and utility owners shall make thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which might be damaged by construction operations. Periodic reexamination shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.
2. Record observations for signature of RESIDENT ENGINEER and CONTRACTOR.

B. Documentation:

1. Submit two copies of photographs or other records documenting examination for RESIDENT ENGINEER's signature. RESIDENT ENGINEER will review, sign, and return one record copy of every observation document and photograph to CONTRACTOR to be kept on file in CONTRACTOR's field office as site records.
2. These observations and photographs are intended for use as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of CONTRACTOR's operations, and are

for protection of adjacent property owners, CONTRACTOR, and OWNER.

1.8 OWNER FACILITIES

A. Operation and Shutdown of Existing Facilities:

1. Continuous operation of OWNER's facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified.
2. Conduct Work outside regular working hours on prior written consent of OWNER to meet Project schedule and avoid undesirable conditions.
3. Do not proceed with Work affecting a facility's operation without obtaining OWNER's advance approval of the need for and duration of such Work.
4. Provide 7 days advance request for approval to OWNER of need to shut down a process or facility.

B. Relocation of Existing Facilities:

1. During construction, it is expected that minor relocations of Work will be necessary.
2. Provide complete relocation of existing structures and Underground Facilities, including piping, utilities, equipment, structures, electrical conduit wiring, electrical duct bank, and other necessary items.
3. Use only new materials for relocated facility. Match materials of existing facility, unless otherwise shown or specified.
4. Perform relocations to minimize downtime of existing facilities.
5. Install new portions of existing facilities in their relocated position prior to removal of existing facilities, unless otherwise accepted by RESIDENT ENGINEER.

1.9 PHYSICAL CONDITIONS

A. Exercise reasonable care to verify locations of existing subsurface structures and Underground Facilities.

B. Thoroughly check immediate and adjacent areas subject to excavation by visual examination (and by electronic metal and pipe detection equipment, as necessary) for indications of subsurface structures and Underground Facilities.

C. Make exploratory excavations where existing Underground Facilities or structures may potentially conflict with proposed Underground Facilities or structures. Conduct exploratory excavations in presence of RESIDENT ENGINEER and sufficiently ahead of construction to avoid possible delays to CONTRACTOR's Work.

1.10 REFERENCE POINTS AND SURVEYS

A. Dimensions for lines and elevations for grades of structures, appurtenances, and utilities are indicated on Drawings, together with other pertinent

information required for laying out Work. If conditions vary from those indicated, notify RESIDENT ENGINEER immediately, who will make minor adjustments required.

B. Any existing survey points or other control markers destroyed without proper authorization will be replaced by owner of the survey points or control markers at the CONTRACTOR's expense.

C. CONTRACTOR's Responsibilities:

1. Locate and protect reference points prior to starting site preparation.
2. Notify RESIDENT ENGINEER at least 3 working days in advance of time when grade and line to be provided by others will be needed.
3. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
4. In event of discrepancy in data or staking provided by RESIDENT ENGINEER, request clarification before proceeding with Work.
5. Preserve and leave undisturbed control staking until RESIDENT ENGINEER has completed checks it deems necessary.
6. Re-establish reference points resulting from destruction by CONTRACTOR's operations.
7. Provide competent employee(s), tools, stakes, and other equipment and materials as RESIDENT ENGINEER may require to:
   a. Check layout, survey, and measurement Work performed by others.
   b. Measure quantities for payment purposes.
8. Cooperate with RESIDENT ENGINEER so that checking and measuring may be accomplished with least interference to CONTRACTOR's operations.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 CUTTING, FITTING, AND PATCHING

A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.

B. Obtain prior written authorization of RESIDENT ENGINEER before commencing Work to cut or otherwise alter:

1. Structural or reinforcing steel, structural columns or beams, elevated slabs, trusses, or any other structural member.
2. Weather- or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Work of others.

C. Refinish surfaces to provide an even finish.

1. Refinish continuous surfaces to nearest intersection.
2. Refinish entire assemblies.

3. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and Work is evident in finished surfaces.

D. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown.

E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use best recommended practice of manufacturer or appropriate trade association.

F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.

G. Remove specimens of installed Work for testing when requested by RESIDENT ENGINEER.

END OF SECTION

SECTION 01092
ABBREVIATIONS

PART 1 GENERAL

1.1 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided herein and in the individual Specification sections.

B. Work specified by reference to the published standard or specification of a government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall meet the requirements or surpass the minimum standards of quality for materials and workmanship established by the designated standard or specification.

C. Where so specified, products or workmanship shall also meet or exceed the additional prescriptive or performance requirements included within the Contract Documents to establish a higher or more stringent standard of quality than that required by the referenced standard.

D. Where two or more standards are specified to establish quality, the product and workmanship shall meet or exceed the requirements of the most stringent.

E. Where both a standard and a brand name are specified for a product in the Contract Documents, the proprietary product named shall meet or exceed the requirements of the specified reference standard.

F. Copies of standards and specifications of technical societies:

1. Copies of applicable referenced standards have not been bound in these Contract Documents.
2. Where copies of standards are needed by the CONTRACTOR, obtain a copy or copies directly from the publication source and maintain in an orderly manner at the site as Work site records, available to the CONTRACTOR's personnel, Subcontractors, OWNER, and RESIDENT ENGINEER.

1.2 ABBREVIATIONS

A. Abbreviations for trade organizations and government agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used.

1. AA Aluminum Association
2. AABC Associated Air Balance Council
3. AAMA American Architectural Manufacturers Association

4.	AASHTO	American Association of State Highway and Transportation Officials
5.	ACI	American Concrete Institute
6.	AFBMA	Anti-Friction Bearing Manufacturers' Association
7.	AGA	American Gas Association
8.	AGMA	American Gear Manufacturers' Association
9.	AI	Asphalt Institute
10.	AISC	American Institute of Steel Construction
11.	AISI	American Iron and Steel Institute
12.	AITC	American Institute of Timber Construction
13.	ALS	American Lumber Standards
14.	AMA	Acoustical Materials Association
15.	AMCA	Air Movement and Control Association
16.	ANSI	American National Standards Institute
17.	APA	American Plywood Association
18.	API	American Petroleum Institute
19.	APWA	American Public Works Association
20.	AREA	American Railway Engineering Association
21.	ARI	Air Conditioning and Refrigeration Institute
22.	ASA	American Standards Association
23.	ASAE	American Society of Agricultural Engineers
24.	ASCE	American Society of Civil Engineers
25.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
26.	ASNT	American Society for Nondestructive Testing
27.	ASME	American Society of Mechanical Engineers
28.	ASTM	American Society for Testing and Materials
29.	AWI	Architectural WoodWork Institute
30.	AWPA	American Wood Preservers' Association
31.	AWPB	American Wood Preservers Bureau
32.	AWPI	American Wood Preservers' Institute
33.	AWS	American Welding Society
34.	AWWA	American Water Works Association
35.	BHMA	Builders Hardware Manufacturers' Association
36.	CBMA	Certified Ballast Manufacturers' Association
37.	CDA	Copper Development Association
38.	CGA	Compressed Gas Association
39.	CIPRI	Cast Iron Pipe Research Institute
40.	CISPI	Cast Iron Soil Pipe Institute
41.	CMAA	Crane Manufacturers' Association of America
42.	CRSI	Concrete Reinforcing Steel Institute
43.	CS	Commercial Standard
44.	CSA	Canadian Standards Association
45.	CSI	Construction Specifications Institute
46.	CTSS	Caltrans Standard Specification
47.	EJCDC	Engineers Joint Contract Documents' Committee
48.	ETL	Engineering Test Laboratories
49.	FCC	Federal Communications Commission
50.	FEMA	Federal Emergency Management Agency
51.	FGMA	Flat Glass Marketing Association
52.	FM	Factory Mutual
53.	Fed. Spec.	Federal Specifications
54.	FS	Federal Specification

55.	GA	Gypsum Association
56.	HI	Hydraulic Institute
57.	HMI	Hoist Manufacturers' Institute
58.	ICBO	International Conference of Building Officials
59.	ICEA	Insulated Cable Engineers' Association
60.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
61.	IES	Illuminating Engineering Society
62.	IFI	Industrial Fasteners Institute
63.	ISA	Instrument Society of America
64.	ISO	Insurance Service Office
65.	JIC	Joint Industry Conferences of Hydraulic Manufacturers
66.	MAG	Maricopa Association of Governments, Uniform Standard Specifications and Details for Public Works Construction
67.	MIA	Marble Institute of America
68.	Mil. Sp. or MIL	Military Specification
69.	MS	Military Specifications
70.	MMA	Monorail Manufacturers' Association
71.	NAAMM	National Association of Architectural Metal Manufacturers
72.	NACE	National Association of Corrosion Engineers
73.	NBHA	National Builders' Hardware Association
74.	NEC	National Electrical Code
75.	NECA	National Electrical Contractor's Association
76.	NEMA	National Electrical Manufacturers' Association
77.	NESC	National Electric Safety Code
78.	NFPA	National Fire Protection Association
79.	NHLA	National Hardwood Lumber Association
80.	NHPMA	Northern Hardwood and Pine Manufacturer's Association
81.	NLMA	National Lumber Manufacturers' Association
82.	NRCA	National Roofing Contractors Association
83.	NSF	National Sanitation Foundation Testing Laboratory
84.	NSPE	National Society of Professional Engineers
85.	NTMA	National Terrazzo and Mosaic Association
86.	NWWDA	National Wood Window and Door Association
87.	OECI	Overhead Electrical Crane Institute
88.	OSHA	Occupational Safety and Health Act (both Federal and State)
89.	PCI	Prestressed Concrete Institute
90.	PEI	Porcelain Enamel Institute
91.	PPI	Plastic Pipe Institute
92.	PS	Product Standards Section—U.S. Department of Commerce
93.	RMA	Rubber Manufacturers' Association
94.	SAE	Society of Automotive Engineers
95.	SCPRF	Structural Clay Products Research Foundation
96.	SDI	Steel Deck Institute
97.	SDI	Steel Door Institute
98.	SIGMA	Sealed Insulating Glass Manufacturing Association
99.	SJI	Steel Joist Institute

100.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
101.	SPI	Society of the Plastics Industry
102.	SSPC	Steel Structures Painting Council
103.	SWI	Steel Window Institute
104.	TEMA	Tubular Exchanger Manufacturers' Association
105.	TCA	Tile Council of America
106.	UBC	Uniform Building Code
107.	UFC	Uniform Fire Code
108.	UL	Underwriters Laboratories Inc.
109.	UMC	Uniform Mechanical Code
110.	US	U.S. Bureau of Standards
111.	USBR	Bureau of Reclamation
112.	WCLIB	West Coast Lumber Inspection Bureau
113.	WWPA	Western Wood Products Association

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01300
SUBMITTALS

PART 1 GENERAL

1.1 GENERAL

A. Inquiries: Direct to RESIDENT ENGINEER regarding procedure, purpose, or extent of Submittal.

B. Timeliness: Schedule and make submissions in accordance with requirements of individual Specification sections and in such sequence as to cause no delay in Work or in work of other contractors.

C. Identification of Submittals:

1. Complete, sign, and transmit with each Submittal package, one Transmittal of CONTRACTOR's Submittal Form.
2. Identify each Submittal with the following numbering and tracking system:
   a. Sequentially number each Submittal.
   b. Resubmission of a Submittal will have original number with sequential alphabetic suffix.
3. Format: Orderly, indexed with labeled tab dividers.
4. Show date of submission.
5. Show Project title and OWNER's contract identification and contract number.
6. Show names of CONTRACTOR, Subcontractor or Supplier, and manufacturer as appropriate.
7. Identify, as applicable, Contract Document section and paragraph to which Submittal applies.
8. Identify Submittal type; submit only one type in each Submittal package.
9. Identify and indicate each deviation or variation from Contract Documents.

D. Resubmissions: Clearly identify each correction or change made.

E. Incomplete Submittal Submissions:

1. RESIDENT ENGINEER will return the entire Submittal for CONTRACTOR's revision/correction and resubmission.
2. Submittals which do not clearly bear CONTRACTOR's specific written indication of CONTRACTOR review and approval of Submittal or which are transmitted with an unsigned or uncertified submission form or as may otherwise be required will be returned to CONTRACTOR unreviewed.

F. Nonspecified Submissions: Submissions not required under these Contract Documents and not shown on submissions will not be reviewed and will be returned to CONTRACTOR.

G. RESIDENT ENGINEER's Review: RESIDENT ENGINEER will act upon CONTRACTOR's Submittal and transmit response to CONTRACTOR not later than 30 days after receipt, unless otherwise specified. Resubmittals will be subject to the same review time.

H. Schedule Delays:

1. No adjustment of Contract Times or Price will be allowed due to RESIDENT ENGINEER's review of Submittals, unless all of the following criteria are met:
   a. CONTRACTOR has notified RESIDENT ENGINEER in writing that timely review of Submittal in question is critical to progress of Work, and has received RESIDENT ENGINEER's written acceptance to reflect such on current accepted submissions and progress schedule. Written agreement by RESIDENT ENGINEER to reduce Submittal review time will be made only for unusual and CONTRACTOR-justified reasons. Acceptance of a progress schedule containing Submittal review times less than specified or less than agreed to in writing by RESIDENT ENGINEER will not constitute RESIDENT ENGINEER's acceptance of the review times.
   b. RESIDENT ENGINEER has failed to review and return first submission of a Submittal within agreed time indicated on current accepted schedule of submissions or, if no time is indicated thereon, within 30 days after receipt.
   c. CONTRACTOR demonstrates that delay in progress of Work is directly attributable to RESIDENT ENGINEER's failure to return Submittal within time indicated and accepted by RESIDENT ENGINEER.
2. No adjustment of Contract Times or Price will be allowed due to delays in progress of Work caused by rejection and subsequent resubmission of Submittals, including multiple resubmissions.

1.2 SHOP DRAWINGS AND SAMPLES

A. Copies:

1. Shop Drawings and Product Data: Seven.
2. Samples: Three, unless otherwise specified in individual Specification sections.

B. General: Submit to RESIDENT ENGINEER as required by individual Specification sections. RESIDENT ENGINEER will distribute to DESIGN ENGINEER for review.

C. Identify and Indicate:

1. Pertinent Drawing sheet(s) and detail number(s), products, units and assemblies, and system or equipment identification or tag numbers.
2. Critical field dimensions and relationships to other critical features of Work.
3. Samples: Source, location, date taken, and by whom.
4. Each deviation or variation from Contract Documents.

D. Design Data: When specified, provide Project-specific information as required and as necessary to clearly show calculations, dimensions, logic and assumptions, and referenced standards and codes upon which design is based.

E. Foreign Manufacturers: When proposed, include following additional information:

1. Names and addresses of at least two companies closest to Project that maintain technical service representatives.
2. Complete inventory of spare parts and accessories for each piece of equipment.

F. Preparation:

1. Format: Whenever possible, schedule for and combine Shop Drawings and Samples required for submission in each Specification section or division into a single Submittal package. Also combine product data for like items into a single Submittal package.
2. Present in a clear and thorough manner and of sufficient detail to show kind, size, arrangement, and function of components, materials, and devices and compliance with Contract Documents. Identify details by reference to sheet and detail, and schedule or room numbers shown on Drawings.
3. Reproducible Copy:
   a. Preferred Minimum Sheet Size: 8-1/2- by 11-inch and 11- by 17-inch pages, suitable for photocopying.
   b. Larger than 11- by 17-Inch Sheets: 22-inch by 34-inch preferred, mylar or sepias suitable for copying in a blueprint machine.
4. Piping Systems: Drawn to scale.
5. Product Data: Clearly mark each copy to identify pertinent products or models and show performance characteristics and capacities, dimensions and clearances required, wiring or piping diagrams and controls, and external connections, anchorages, and supports required.
6. Equipment and Component Titles: Identical to title shown on Drawings.
7. Manufacturer's standard schematic drawings and diagrams as follows:
   a. Modify to delete information that is not applicable to Work.
   b. Supplement standard information to provide information specifically applicable to Work.

G. Shop Drawing Disposition: DESIGN ENGINEER will review, mark, and stamp as appropriate and submit copies to RESIDENT ENGINEER. RESIDENT ENGINEER will distribute marked-up copies as noted:

1. Approved as Submitted (for incorporation in Work):
   a. One copy furnished OWNER.
   b. One copy retained in DESIGN ENGINEER's file.
   c. One copy retained in RESIDENT ENGINEER's file.
   d. Remaining copies returned to CONTRACTOR appropriately annotated.

e. CONTRACTOR may begin to implement activities to incorporate specific product(s) or Work covered by Submittal.

2. Approved as Noted (for incorporation in Work):
   a. One copy furnished OWNER.
   b. One copy retained in DESIGN ENGINEER's file.
   c. One copy retained in RESIDENT ENGINEER's file.
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR may begin to implement activities to incorporate product(s) or Work covered by Submittal, in accordance with ENGINEER's notations.
3. Disapproved:
   a. One copy furnished OWNER.
   b. One copy retained in DESIGN ENGINEER's file.
   c. One copy retained in RESIDENT ENGINEER's file.
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR shall make corrections or develop replacement and resubmit (in same manner and quantity as specified for original submission).
   f. Submittal is not approved.
4. Incomplete:
   a. One copy furnished OWNER.
   b. One copy retained in DESIGN ENGINEER's file.
   c. One copy retained in RESIDENT ENGINEER's file.
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR shall complete and resubmit or submit missing portions.
   f. Submittal is not approved.

H. Sample Disposition: Same as Shop Drawing disposition; samples will not be returned.

1.3 ADMINISTRATIVE SUBMITTALS

A. Copies: Submit six.

B. Description: Submittals that are not Shop Drawings or Samples, or that do not reflect quality of product or method of construction. May include, but not limited to those Submittals identified below.

C. Applications for Payment: Meet requirements of Section 01025, MEASUREMENT AND PAYMENT.

D. Progress Reports and Quantity Charts: As may be required in Section 01310, PROGRESS SCHEDULES.

E. Schedules:

1. Progress Schedule(s): Meet the requirements of Section 01310, PROGRESS SCHEDULES.

2. Schedule of Values: Meet requirements of Section 01025, MEASUREMENT AND PAYMENT.
3. Schedule of Submittal Submissions:
   a. Prepare and submit, preliminary list of submissions grouped by Contract Document article/paragraph number or Specification section number, with identification, numbering and tracking system as specified under Paragraph Identification of Submittals and as approved by RESIDENT ENGINEER.
   b. Include only the following required submissions:
      1) Shop Drawings and Samples.
      2) Training plans.
      3) Test procedures.
      4) Operation and maintenance manuals.
      5) Record documents.
      6) Specifically required certificates, warranties, and service agreements.
   c. Coordinate with progress schedule and prepare submissions to show for each Submittal, at a minimum, the following:
      1) Estimated submission date to RESIDENT ENGINEER.
      2) Specifically requested and clearly identified RESIDENT ENGINEER review time if shorter than that set forth herein, with justification for such request and critical dates Submittals will be needed from RESIDENT ENGINEER.
      3) For first 6-month period from the date the Contract Times commence or following any update or adjustment of the submissions, the estimated submission date shall be week, month, and year; for submissions beyond 6-month time period, show closest month and year.
   d. Submit to RESIDENT ENGINEER monthly (i) updated list if changes have occurred, otherwise submit a written communication confirming existing list, and (ii) adjusted submissions reflecting submission activity planned for forthcoming 6-month time period and beyond. Coordinate with progress schedule updates.

F. Training Materials: Meet the requirements of Section 01640, MANUFACTURERS' SERVICES.

G. Submittals Required by Laws, Regulations, and Governing Agencies:

1. Submit promptly notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
2. Transmit to RESIDENT ENGINEER for OWNER's records one copy of correspondence and transmittals (to include enclosures and attachments) between CONTRACTOR and governing agency.

H. Disposition: RESIDENT ENGINEER will review, stamp, and indicate requirements for resubmission or acceptance on Submittal as follows:

1. Accepted:
   a. Schedules: Acceptance will indicate that schedules provide for the orderly progression of the Work to completion within any

specified milestones and the Contract Times, but such acceptance will neither impose on RESIDENT ENGINEER responsibility for the sequencing, scheduling, or progress of the Work nor interfere with or relieve CONTRACTOR from CONTRACTOR's full responsibility therefor.

b. Acceptance of other Administrative Submittals will indicate that Submittal conforms to intent of Contract Documents as to form and substance.

c. CONTRACTOR may proceed to perform Submittal related Work.

d. One copy furnished OWNER.

e. One copy retained in RESIDENT ENGINEER's file.

f. Remaining copies returned to CONTRACTOR appropriately annotated.

2. Rejected as Noted:

a. One copy retained in RESIDENT ENGINEER's file.

b. Remaining copies returned to CONTRACTOR appropriately annotated.

c. CONTRACTOR shall revise/correct or develop replacement and resubmit.

1.4 QUALITY CONTROL SUBMITTALS

A. Copies: Submit seven.

B. Certificates:

1. Manufacturer's Certificate of Compliance:

a. When specified in individual Specification sections or where products are specified to a recognized standard or code, submit prior to shipment of product or material to the site.

b. DESIGN ENGINEER may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.

c. Signed by product manufacturer certifying that materials, manufacture, and product specified conforms to or exceeds specified requirements and intent for which product will be used. Submit supporting reference data, affidavits, and certifications as appropriate.

d. May reflect recent or previous test results on material or product, but must be acceptable to DESIGN ENGINEER.

2. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in the individual Specification sections.

3. Manufacturer's Certificate of Proper Installation: As required in Section 01640, MANUFACTURERS' SERVICES. Coordinate with Section 01650, FACILITY STARTUP.

C. Operation and Maintenance Manual: As required in Section 01430, OPERATION AND MAINTENANCE DATA.

D. Statements of Qualification: Evidence of qualification, certification, or registration. As required in these Contract Documents to verify

qualifications of professional land surveyors, engineers, materials testing laboratories, specialty Subcontractors, trades, specialists, consultants, installers, and other professionals.

E. Field Samples: Provide as required by individual Specifications and as may be required by RESIDENT ENGINEER during progress of Work.

F. Written Test Reports of Each Test and Inspection: As a minimum, include the following:

1. Date of test and date issued, Project title and number, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
2. Date and time of sampling or inspection and record of temperature and weather conditions.
3. Identification of product and Specification section, location of Sample, test or inspection in the Project, type of inspection or test with referenced standard or code, certified results of test.
4. Compliance with Contract Documents, and identifying corrective action necessary to bring materials and equipment into compliance.
5. Provide an interpretation of test results, when requested by RESIDENT ENGINEER.

G. Disposition: DESIGN ENGINEER will review, mark, and stamp as appropriate and submit copies to RESIDENT ENGINEER. RESIDENT ENGINEER will distribute marked-up copies as noted:

1. Accepted:
   a. Acceptance will indicate that Submittal conforms to intent of Contract Documents as to form and substance.
   b. CONTRACTOR may proceed to perform Submittal related Work.
   c. One copy furnished OWNER.
   d. One copy retained in DESIGN ENGINEER's file.
   e. One copy retained in RESIDENT ENGINEER's file.
   f. Remaining copies returned to CONTRACTOR appropriately annotated.
2. Rejected as Noted:
   a. One copy retained in DESIGN ENGINEER's file.
   b. One copy retained in RESIDENT ENGINEER's file.
   c. Remaining copies returned to CONTRACTOR appropriately annotated.
   d. CONTRACTOR shall revise/correct or develop replacement and resubmit.

1.5 CONTRACT CLOSEOUT SUBMITTALS

A. General: In accordance with Section 01700, CONTRACT CLOSEOUT.

B. Disposition: RESIDENT ENGINEER will review, stamp, and indicate requirements for resubmission or acceptance on Submittal as follows:

1. Accepted:
   a. Acceptance will indicate that Submittal conforms to intent of Contract Documents as to form and substance.
   b. CONTRACTOR may proceed to perform Submittal related Work.
   c. One copy furnished OWNER.
   d. One copy retained in RESIDENT ENGINEER's file.
   e. Remaining copies returned to CONTRACTOR appropriately annotated.
2. Rejected as Noted:
   a. One copy retained in RESIDENT ENGINEER's file.
   b. Remaining copies returned to CONTRACTOR appropriately annotated.
   c. CONTRACTOR shall revise/correct or develop replacement and resubmit.

1.6 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION", are part of this Specification.

1. Forms: Transmittal of CONTRACTOR's Submittal

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

CH2M HILL **TRANSMITTAL OF CONTRACTOR'S SUBMITTAL**
(ATTACH TO EACH SUBMITTAL)

DATE:_____

TO:_____

_____

_____

_____

_____

FROM:_____

Contractor

_____

_____

_____

Submittal No.:_____

☐ New Submittal ☐ Resubmittal

Previous Submittal No.:_____

Project:_____

Project No.:_____

Specification Section No.:_____

(Cover only one section with each transmittal)

Schedule Date of Submittal:

_____

SUBMITTAL TYPE: ☐ Shop Drawing ☐ Administrative ☐ Sample ☐ Quality Control ☐ Contract Closeout ☐ "Or-Equal"/Substitute

The following items are hereby submitted:

Number of Copies	Description of Item Submitted (Type, Size, Model Number, Etc.)	Spec. Para. No.	Drawing or Brochure Number	Contains Variation to Contract	
				No	Yes

CONTRACTOR hereby certifies that (i) CONTRACTOR has complied with the requirements of Contract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Contract Documents and requirements of laws and regulations and governing agencies.

By:_____

CONTRACTOR (Authorized Signature)

SECTION 01310
PROGRESS SCHEDULES

PART 1 GENERAL

1.1 SUBMITTALS

A. Submit with Each Progress Schedule Submission:

1. CONTRACTOR's certification that progress schedule submission is the actual schedule being utilized for execution of the Work and certification by all Subcontractors with 5 percent or more of Work that they concur with CONTRACTOR's progress schedule submission.
2. Four Legible Copies of the Progress Schedule: For each computer generated schedule submission.
3. Disk file compatible with Primavera Project Planner (P3).

B. Preliminary Progress Schedule: Submit within 10 days of award. No progress payment shall be made to CONTRACTOR until the schedules are submitted and acceptable to RESIDENT ENGINEER. Schedule shall comply with the requirements of MAG paragraph 108.4.

C. Progress Schedule: Submit adjusted schedule or confirm validity of current schedule with each monthly Application for Payment, and at such other times as necessary to reflect: (i) progress of Work to within 5 working days prior to submission; (ii) changes in Work scope and activities modified since submission; (iii) delays in Submittals or resubmittals, deliveries, or Work; (iv) adjusted or modified sequences of Work; (v) other identifiable changes; and (vi) revised projections of progress and completion. Schedule shall comply with the requirements of MAG paragraph 108.4.

D. Narrative Progress Report: Submit with each monthly submission of progress schedule.

E. Precedent to final payment, provide four copies of any Critical Path Method (CPM) type schedule utilized with certification that said schedule represents correctly the way the Work was performed.

F. Progress quantity chart(s).

1.2 SCHEDULE RESPONSIBILITIES

A. Project is divided into several prime contracts with each contract awarded separately. OWNER's construction manager will be responsible for developing and maintaining a master progress schedule utilizing individual progress schedules prepared by each contractor as submitted to RESIDENT ENGINEER under this section.

B. CONTRACTOR's construction schedule must conform to the prescribed work in the sequence shown on the Rio Salado Town Lake Coordination

Schedule (Exhibit A), and specified notes therein. Certain work and progress direction is specified.

C. Upon review and acceptance, RESIDENT ENGINEER will transmit one hard copy and one diskette copy, Primavera Project Planner (P3), each for all contractors' schedules to OWNER's construction manager. Within 5 days of receipt, OWNER's construction manager shall prepare and transmit to RESIDENT ENGINEER one hard copy of master progress schedule for each designated contractor and one hard copy for RESIDENT ENGINEER.

D. Where CONTRACTOR is referred to in the singular, it shall refer to each of separate contractors as applicable.

1.3 PROGRESS OF THE WORK

A. If CONTRACTOR fails to complete activity by its latest scheduled completion date and this failure may extend Contract Times (or Milestones), CONTRACTOR shall, within 7 days of such failure, submit a written statement as to how CONTRACTOR intends to correct nonperformance and return to the acceptable current progress schedule. Actions by CONTRACTOR to complete Work within Contract Times (or Milestones) will not be justification for adjustment to Contract Price or Contract Times.

B. OWNER may order CONTRACTOR to increase plant, equipment, labor force or working hours if CONTRACTOR fails to: (i) complete a critical scheduled activity by its latest Milestone completion date, or (ii) satisfactorily execute Work as necessary to prevent delay to the overall completion of the Project.

1.4 PRELIMINARY PROGRESS SCHEDULE

A. As a minimum, submit two bar charts or preliminary network analysis diagrams as follows:

1. 90-Day Plan: Show major initial activities including, but not limited to, mobilization, permits, submittals for early product procurement and long lead time items, initial site work, and other activities anticipated in the first 90-day period of the Contract Time.
2. Project Overview Plan: Show major components of the Work and the sequence relations between major components and subdivisions of major components. The chart shall indicate the relationship and time frames in which the various facilities will be made substantially complete and placed into service in accordance with the Project Milestones. Sufficient detail shall be included for the identification of subdivisions of major components into such activities as:
   a. Excavation.
   b. Foundation subgrade preparation.
   c. Foundation concrete.
   d. Completion of all structural concrete.
   e. Major mechanical Work.
   f. Major electrical Work.

g. Instrumentation and control Work.
h. Other important work for each major facility within the overall Work scope.

B. Planned durations and start dates shall be indicated for each Work item subdivision. Each major component and subdivision component shall be accurately plotted on time scale sheets not to exceed 11 inches by 17 inches in size. Not more than four sheets shall be employed to represent this overview information.

C. The preliminary progress schedule, when accepted by the RESIDENT ENGINEER, will be the initially acceptable schedule.

1.5 PROGRESS SCHEDULE

A. General:

1. Schedule(s) shall reflect Work logic sequences, restraints, delivery windows, review times, Contract Times, and Milestones set forth in the Agreement and Section 01040, COORDINATION, and shall begin with the date of Notice to Proceed and conclude with the date of Final Completion.
2. The schedule requirement herein is the minimum required. CONTRACTOR may prepare a more sophisticated schedule if such will aid CONTRACTOR in execution and timely completion of Work.
3. Base schedule on standard 5-day Work week.
4. When bar chart or network analysis schedules are specified, use Primavera Project Planner (P3) latest version or a compatible and approved software.
5. Adjust or confirm schedules on a monthly basis.
6. Float time is a Project resource available to both parties to meet contract Milestones and Contract Times.
7. Use of float suppression techniques such as preferential sequencing or logic, special lead/lag logic restraints, and extended activity times are prohibited, and use of float time disclosed or implied by use of alternate float-suppression techniques shall be shared to proportionate benefit of OWNER and CONTRACTOR.
8. Pursuant to above float-sharing requirement, no time extensions will be granted nor delay damages paid until a delay occurs which (i) impacts Project's critical path, (ii) consumes available float or contingency time, and (iii) extends Work beyond contract completion date.
9. If CONTRACTOR provides an accepted schedule with an early completion date, OWNER reserves the right to reduce Contract Times to match the early completion date by issuing a deductive Change Order at no change in Contract Price.

B. Format:

1. Comprehensive computer generated Network Analysis Diagram schedule using CPM, generally as outlined in Associated General Contractors of America (AGC) publication "The Use of CPM in Construction—A Manual for General Contractors and the Construction

Industry," latest edition, prepared on reproducible paper, not larger than 30 inches by 42 inches.

a. Submit within 45 days after the Contract Times start to run.
b. Show complete interdependence and sequence of construction and Project-related activities reasonably required to complete the Work, identifying Work of separate stages and other logically grouped activities, and clearly identify critical path of activities.
c. Include at a Minimum: Subcontract Work; major and other equipment and critical product design, fabrication, testing, delivery and installation times including required lead time for OWNER-furnished products, move-in and other preliminary activities, Project closeout and cleanup, Substantial Completion dates, Submittals that may impact critical path, and system/ subsystem/component testing, facility startup, and training activities that may impact critical path.
d. Develop subschedules to further define critical portions of the Work, i.e., Process Instrumentation and Control System/ Subsystems.
e. Indicate dates for early- and late-start, early- and late-finish, float and duration.
f. No activity duration, exclusive of those for Submittals review and product fabrication/delivery, shall be less than 1 day nor more than 15 working days, unless otherwise approved by RESIDENT ENGINEER.
g. Activity duration for Submittals review shall not be less than review time specified unless clearly identified and prior written acceptance has been obtained from RESIDENT ENGINEER.
h. Monthly Schedule Submissions: Include overall percent complete, projected and actual; and percent completion progress for each listed activity.
i. The estimated cost to perform each Work activity shall be noted for each activity in the network on a tabular listing. The sum of the costs assigned to all activities shall equal the Contract Price. No activity costs shall be assigned to Submittals or Submittal reviews. An unbalanced or front-end loaded schedule will not be acceptable. The accepted cost loaded progress schedule shall constitute the schedule of values specified in Section 01025, MEASUREMENT AND PAYMENT.

1.6 NARRATIVE PROGRESS REPORT

A. Include, as a minimum:

1. Summary of Work completed during the past period between Narrative Progress Reports.
2. Work planned during the next period.
3. Explanation of differences between summary of Work completed and Work planned in previously submitted Narrative Progress Report.
4. Current and anticipated delaying factors and their estimated impact on other activities and completion Milestones.
5. Corrective action taken or proposed.

1.7 CLAIMS FOR ADJUSTMENT OF CONTRACT TIMES

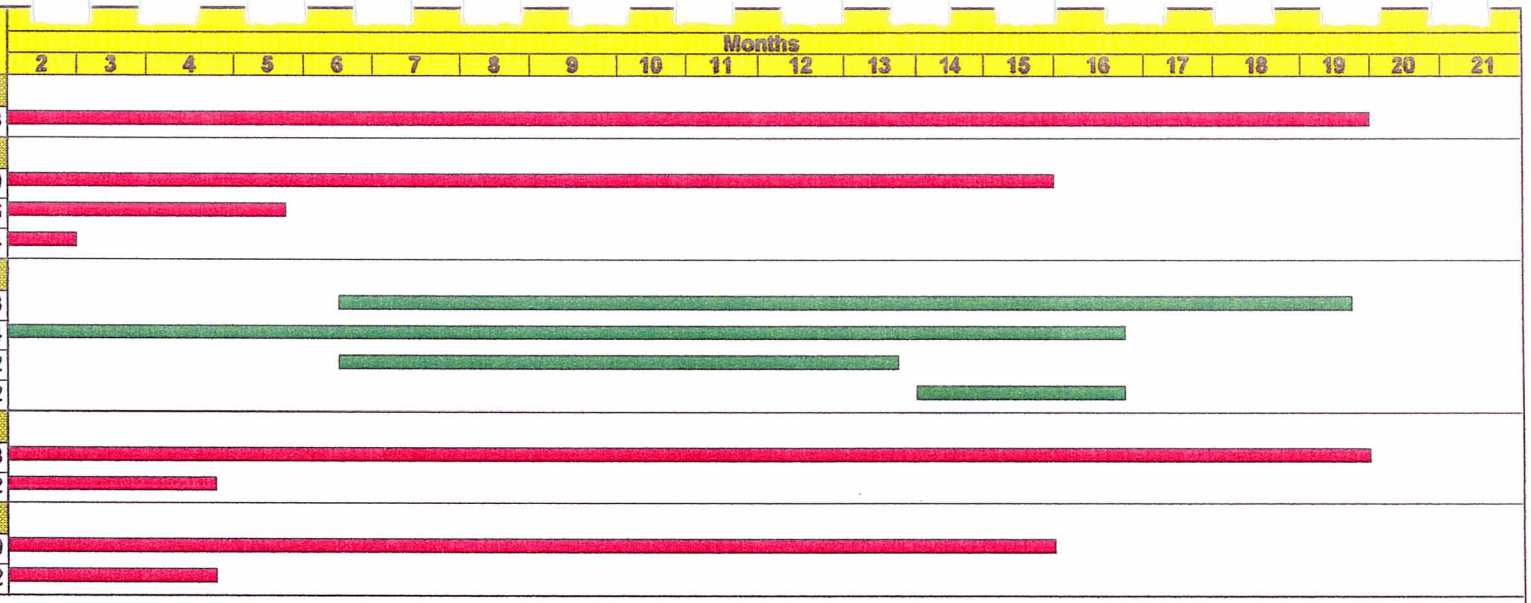
A. Where RESIDENT ENGINEER has not yet rendered formal decision on CONTRACTOR's claim for adjustment of Contract Times, and parties are unable to agree as to amount of adjustment to be reflected in progress schedule, CONTRACTOR shall reflect that amount of time adjustment in progress schedule as RESIDENT ENGINEER may accept as appropriate for the interim. It is understood and agreed that such interim acceptance by RESIDENT ENGINEER will not be binding and will be made only for purpose of continuing to schedule Work, until such time as formal decision as to an adjustment, if any, of the Contract Times acceptable to the RESIDENT ENGINEER has been rendered. CONTRACTOR shall revise progress schedule prepared thereafter in accordance with RESIDENT ENGINEER's formal decision.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

ID	Task Name	Duration
	Total Project	
1	construction activities	78
	Schedule A	
2	pipe/wells	60
3	CSA penetrations	16
4	abandon wells	4
	Schedule B	
5	dams	58
6	dam procurement	64
7	downstream dam	32
8	dam installiation	12
	Schedule C	
9	shoreline	78
10	CSA demo	12
	Schedule D	
11	cutoff wall	60
12	cement-bentonite cutoff wall	12



1. General construction schedule is shown for coordination and reference.

2. All durations and end points shown are critical in order to coordinate work to occur in adjacent areas. Failure to complete specified work within the time allocated will subject contract to damages, due to consequential conflict with other scheduled activities, according to the specification for liquidated damage. (See specification index).

3. Down stream dam foundation must be constructed first, as shown.

4. Other schedule "B" work may be accomplished concurrently.

5. Rubber dams to be owner supplied. Imbed hardware is critical path item.

Project Start	30DEC96
Project Finish	22JUN98
Data Date	30DEC96
Plot Date	06SEP98

(c) Primavera Systems, Inc.

Early Bar
Progress Bar
Critical Activity

RSTL

Sheet 1 of 1

Parsons Brinckerhoff C. S.

Rio Salado Town Lake

Construction Coordination Schedule B

SECTION 01430
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 DEFINITIONS

A. Maintenance Operation: As used in the Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

B. System and Subsystem: Refer to Section 01650, FACILITY STARTUP.

1.2 QUALITY ASSURANCE

A. Manuals for equipment and systems shall be prepared by equipment manufacturer or system Supplier.

1.3 SEQUENCING AND SCHEDULING

A. Manual Outline: Submit detailed outline of each manual prior to preparation of Preliminary Manuals.

B. Manuals for Equipment and Systems:

1. Preliminary Manuals: Submit prior to shipment date for equipment, system, subsystem, or component. Include copy of warranties, Bonds, and service agreements if specified.
2. Final Manuals: Submit not less than 30 days prior to equipment or system field testing or startup.

1.4 GENERAL

A. Furnish for each item of equipment or system as specified in the individual Specification sections.

B. Prepare data for use by OWNER's personnel in the form of an instructional manual and on electronic media.

C. Manual Format:

1. Size: 8-1/2 inches by 11 inches.
2. Paper: 20-pound minimum, white for typed pages.
3. Text: Manufacturer's printed data, or neatly typewritten.
4. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
5. Provide fly-leaf for each separate product, or each piece of operating equipment, with typed description of product and major component

parts of equipment and provide with heavy section dividers with numbered plastic index tabs.

6. Provide each manual with title page, and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.
7. Cover: Identify each volume with typed or printed title "OPERATION AND MAINTENANCE MANUAL, VOLUME NO. __ OF __", if applicable, and list:
   a. Project title.
   b. Designate the system or equipment for which it is intended.
   c. Identity of separate structure as applicable.
   d. Identity of general subject matter covered in manual. Identity of equipment number and Specification section.
8. Assemble and bind material in same order as specified, as much as possible.
9. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.
10. Binders:
    a. Preliminary Manuals: Heavy paper covers.
    b. Final Manuals: Commercial quality, substantial, permanent, three-ring binders with durable, cleanable, plastic binders.
11. Table of contents neatly typewritten, arranged in a systematic order:
    a. CONTRACTOR, name of responsible principal, address, and telephone number.
    b. List of each product required to be included, indexed to content of each volume.
    c. List with Each Product: Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance contractor, as appropriate.
       1) Identify area of responsibility of each.
       2) Provide local source of supply for parts and replacement.
    d. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
12. Product Data:
    a. Include only those sheets that are pertinent to specific product.
    b. Clearly annotate each sheet to:
       1) Identify specific product or part installed.
       2) Identify data applicable to installation.
       3) Delete references to inapplicable information.
13. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
    a. Relations of component parts of equipment and systems.
    b. Control and flow diagrams.
    c. Coordinate drawings with Project record documents to assure correct illustration of completed installation.
    d. Do not use Project record documents as maintenance manual drawings.
    e. Provide reinforced punched binder tab, bind in with text.
    f. Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.

g. Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
h. Identify Specification section and product on Drawings and envelopes.

14. Instructions and Procedures: Within text, as required to supplement product data.
    a. Handling, storage, maintenance during storage, assembly, erection, installation, adjusting, testing, operating, shutdown in emergency, troubleshooting, maintenance, interface, and as may otherwise be required.
    b. Organize in a consistent format under separate heading for each different procedure.
    c. Provide a logical sequence of instructions for each procedure.
    d. Provide information sheet for OWNER's personnel, including:
        1) Proper procedures in the event of failure.
        2) Instances that might affect the validity of warranties or Bonds.
15. Warranties, Bonds, and Service Agreements: In accordance with Section 01700, CONTRACT CLOSEOUT.

D. Electronic Format: Microsoft Word, most current version.

1.5 SUBMITTAL PROCEDURE

A. Preliminary Manuals:

1. Submit seven copies.
2. Disposition: In accordance with Section 01300, SUBMITTALS, Article SHOP DRAWINGS AND SAMPLES.
3. If Accepted:
    a. One copy will be returned to CONTRACTOR.
    b. Four copies will be forwarded to OWNER.
    c. One copy will be retained in DESIGN ENGINEER's file.
    d. One copy will be retained in RESIDENT ENGINEER's file.
4. If Rejected:
    a. One copy will be returned to CONTRACTOR with DESIGN ENGINEER's comments for revision.
    b. One copy will be retained in DESIGN ENGINEER's file.
    c. One copy will be retained in RESIDENT ENGINEER's file.
    d. Resubmit seven revised Preliminary copies for ENGINEER's review.

B. Final Manuals:

1. If different than accepted Preliminary Manuals, submit:
    a. Seven copies of any necessary supplemental material, including revised table of contents.
    b. Instructions for insertion of supplemental material in unreturned sets.
2. If Final Manuals are acceptable, CONTRACTOR will be so notified.
3. If rejected, and at DESIGN ENGINEER's option:
    a. All copies will be returned to CONTRACTOR for revision, or;

b. All copies will be retained and the necessary revision data will be requested from CONTRACTOR.

1.6 MANUALS FOR EQUIPMENT AND SYSTEMS

A. Content for Each Unit (or Common Units) and System:

1. Description of unit and component parts, including controls, accessories, and appurtenances:
   a. Function, normal operating characteristics, and limiting conditions.
   b. Performance curves, engineering data, nameplate data, and tests.
   c. Complete nomenclature and commercial number of replaceable parts.
2. Operating Procedures:
   a. Startup, break-in, routine, and normal operating instructions.
   b. Test procedures and results of factory tests where required.
   c. Regulation, control, stopping, and emergency instructions.
   d. Description of operation sequence by control manufacturer.
   e. Shutdown instructions for both short and extended durations.
   f. Summer and winter operating instructions, as applicable.
   g. Safety precautions.
   h. Special operating instructions.
   i. Installation instructions.
3. Maintenance and Overhaul Procedures:
   a. Routine operations.
   b. Guide to troubleshooting.
   c. Disassembly, removal, repair, reinstallation, and reassembly.
4. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
5. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
6. Spare parts ordering instructions.
7. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).
8. Manufacturer's printed operating and maintenance instructions.
9. As-installed, color-coded piping diagrams.
10. Charts of valve tag numbers, with the location and function of each valve.

B. Maintenance Summary:

1. Compile an individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or subunits.
2. Format:
   a. Use Maintenance Summary Form bound with this section, or an electronic facsimile of such.
   b. Each Maintenance Summary may take as many pages as required.

c. Use only 8-1/2-inch by 11-inch size paper.
d. Complete using typewriter or electronic printing.

3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
4. Recommended Spare Parts:
   a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
   b. "Unit" is the unit of measure for ordering the part.
   c. "Quantity" is the number of units recommended.
   d. "Unit Cost" is the current purchase price.

C. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
   a. Function, normal operating characteristics, and limiting conditions.
   b. Performance curves, engineering data, nameplate data, and tests.
   c. Complete nomenclature and commercial number of replaceable parts.
   d. Interconnection wiring diagrams, including all control and lighting systems.
2. Circuit Directories of Panelboards:
   a. Electrical service.
   b. Controls.
   c. Communications.
3. List of electrical relay settings, and control and alarm contact settings.
4. Electrical interconnection wiring diagram, including control and lighting systems.
5. As-installed control diagrams by control manufacturer.
6. Operating Procedures:
   a. Routine and normal operating instructions.
   b. Sequences required.
   c. Safety precautions.
   d. Special operating instructions.
7. Maintenance Procedures:
   a. Routine operations.
   b. Guide to troubleshooting.
   c. Adjustment and checking.
   d. List of relay settings, control and alarm contact settings.
8. Manufacturer's printed operating and maintenance instructions.
9. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

1.7 MANUALS FOR MATERIALS AND FINISHES

A. Content for Architectural Products, Applied Materials, and Finishes:

1. Manufacturer's data, giving full information on products:
   a. Catalog number, size, and composition.
   b. Color and texture designations.

c. Information required for reordering special-manufactured products.

2. Instructions for Care and Maintenance:
   a. Manufacturer's recommendation for types of cleaning agents and methods.
   b. Cautions against cleaning agents and methods that are detrimental to product.
   c. Recommended schedule for cleaning and maintenance.

B. Content for Moisture Protection and Weather Exposed Products:

1. Manufacturer's data, giving full information on products:
   a. Applicable standards.
   b. Chemical composition.
   c. Details of installation.
2. Instructions for inspections, maintenance, and repair.

1.8 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION", are part of this Specification.

1. Forms: Maintenance Summary Form.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

MAINTENANCE SUMMARY FORM

PROJECT: _____ CONTRACT NO.: _____

1. EQUIPMENT ITEM _____

2. MANUFACTURER _____

3. EQUIPMENT/TAG NUMBER(S) _____

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) _____

5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

6. MANUFACTURER'S LOCAL REPRESENTATIVE

   a. Name _____ Telephone No. _____

   b. Address _____

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant list required.

8. LUBRICANT LIST

Reference Symbol	Shell	Standard Oil	Gulf	Arco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY

Part No.	Description	Unit	Quantity	Unit Cost

Note: Identify parts provided by this Contract with two asterisks.

SECTION 01500
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SUBMITTALS

A. Administrative Submittals: Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.

B. Shop Drawings:

1. Temporary Utility Submittals:
   a. Electric power supply and distribution plans.
   b. Water supply and distribution plans.
   c. Drainage plans.
2. Temporary Construction Submittals:
   a. Access Roads: Routes, cross-sections, and drainage facilities.
   b. Parking area plans.
   c. Storage yard and storage building plans, including gravel surfaced area.
   d. Fencing and protective barrier locations and details.
   e. Staging area location plan.
   f. Traffic Routing Plans: As specified herein, and proposed revisions thereto.
   g. Plan for maintenance of existing plant operations.
3. Temporary Control Submittals:
   a. Noise control plan.
   b. Plan for disposal of waste materials and intended haul routes.

1.2 MOBILIZATION

A. Mobilization shall include, but not be limited to, these principal items:

1. Obtaining required permits.
2. Moving CONTRACTOR's plant and equipment required for first month operations onto site.
3. Installing temporary construction power, wiring, and lighting facilities.
4. Providing onsite communication facilities, including telephones, fax machine, and mailing address.
5. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
6. Arranging for and erection of CONTRACTOR's work and storage yard.
7. Posting OSHA required notices and establishing safety programs and procedures.
8. Having the CONTRACTOR's superintendent at the site full time.

9. Maintain complete field file of Shop Drawings, posted Contract Documents, and other files of field operations including provisions for maintaining "As recorded Drawings."
10. Removing field office from site upon acceptance of the entire work by OWNER.

B. Use area designated for CONTRACTOR's temporary facilities as shown as the staging area on Drawings.

1.3 CONTRACTOR'S USE OF PREMISES

A. Lands furnished by OWNER upon which CONTRACTOR shall perform the Work are as shown in the Drawings.

B. Rights-of-way and easements for access to such lands furnished by OWNER have been acquired. One copy of each easement will be furnished to CONTRACTOR.

1. The Flood Control District of Maricopa County (FCDMC) maintains flood control maintenance easements within the river channel. The typical northern limit of the easement is 15 feet from the leading edge of the existing north channel levee and the typical southern limit is 15 feet from the leading edge of the existing south channel levee.
2. CONTRACTOR is responsible for confining its construction equipment within the limits of the FCDMC easement except where specifically shown on the Drawings.

1.4 PERMITS

A. Permits, Licenses, or Approvals: Obtain in accordance with the General Provisions and as otherwise may be provided in the Special Provisions and retain onsite.

1.5 PROTECTION OF WORK AND PROPERTY

A. Safety Representative: CONTRACTOR shall designate a qualified and experienced safety representative at the site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

B. Comply with OWNER's safety rules.

C. Keep OWNER informed of serious accidents on the site and related claims.

D. Use of Explosives: No blasting or use of explosives will be allowed on the site.

E. During the performance of the Work, CONTRACTOR is responsible for adapting its means, methods, techniques, sequences and procedures of construction to allow OWNER to maintain operation at the existing level of facility production and consistent with applicable permit requirements, and Laws and Regulations. In performing such Work and in cooperating with

the OWNER to maintain operations, it may be necessary for the CONTRACTOR to plan, design, and provide various temporary services, utilities, connections, temporary piping and heating, access, and similar items which will be included within the Contract Price.

1.6 VEHICULAR TRAFFIC

A. Traffic Routing Plan: Show sequences of construction affecting the use of roadways, time required for each phase of the Work, provisions for decking over excavations and phasing of operations to provide necessary access, and plans for signing, barricading, and striping to provide passages for pedestrians and vehicles.

PART 2 PRODUCTS

2.1 RESIDENT ENGINEER'S FIELD OFFICES

A. To be provided by OWNER.

2.2 PROJECT SIGN

A. Provide and maintain an 8-foot wide by 4-foot high sign constructed of 3/4-inch exterior high density overlaid plywood. Sign shall bear the name of Project, OWNER, CONTRACTOR, DESIGN ENGINEER, RESIDENT ENGINEER, and other participating agencies. Lettering shall be blue applied on a white background by an experienced sign painter. Paint shall be exterior type enamel. The information to be included will be provided by the OWNER.

PART 3 EXECUTION

3.1 TEMPORARY UTILITIES

A. Power:

1. Electric power will be available at or near the site. Determine the type and amount available and make arrangements for obtaining temporary electric power service, metering equipment, and pay all costs for the electric power used during the contract period, except for portions of the Work designated in writing by the RESIDENT ENGINEER as substantially complete.
2. Cost of electric power used in performance and acceptance testing will be borne by CONTRACTOR.

B. Lighting: Provide temporary lighting at least to meet all applicable safety requirements to allow erection, application or installation of materials and equipment, and observation or inspection of the Work.

C. Heating, Cooling, and Ventilating:

1. Provide as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions

for the installation of materials, and to protect materials, equipment, and finishes from damage due to temperature or humidity.

2. Provide adequate forced air ventilation of enclosed areas to cure installed materials, to dispense humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
3. Pay all costs of installation, maintenance, operation, removal, and fuel consumed.
4. Provide portable unit heaters, complete with controls, oil- or gas-fired, and suitably vented to outside as required for protection of health and property.
5. If permanent natural gas piping is used for temporary heating units, do not modify or reroute gas piping without approval of utility company. Provide separate gas metering as required by utility.

D. Water:

1. No construction or potable water is available at the site. CONTRACTOR shall make arrangements for and bear all costs of providing water required for construction and potable purposes during construction.
2. Hydrant Water:
   a. Water may be available from hydrants in the Project vicinity. Secure written permission for connection and use from the water department and meet requirements for use. Notify fire department before obtaining water from fire hydrants.
   b. Use only special hydrant-operating wrenches to open hydrants. Make certain that hydrant valve is open full, since cracking the valve causes damage to the hydrant. Repair damaged hydrants and notify the appropriate agency as quickly as possible. Hydrants shall be completely accessible to the fire department at all times.
   c. Include costs to connect and transport water to construction areas in the Contract Price.

E. Sanitary and Personnel Facilities: Provide and maintain facilities for CONTRACTOR's employees, Subcontractors, and all other onsite employer's employees. Service, clean, and maintain facilities and enclosures.

F. Telephone Service: Arrange and provide onsite telephone service for CONTRACTOR's use during construction. Pay all costs of installation and monthly bills.

G. Fire Protection: Furnish and maintain on the site adequate firefighting equipment capable of extinguishing incipient fires. Comply with applicable parts of the National Fire Prevention Standard for Safeguarding Building Construction Operations (NFPA No. 241).

3.2 PROTECTION OF WORK AND PROPERTY

A. General:

1. Perform Work within rights-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.
2. Maintain in continuous service all existing gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and all other utilities encountered along the line of work, unless other arrangements satisfactory to owners of said utilities have been made.
3. Where completion of Work requires temporary or permanent removal and/or relocation of an existing utility, coordinate all activities with owner of said utility and perform all work to their satisfaction.
4. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
5. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
6. In areas where the CONTRACTOR's operations are adjacent to or near a utility such as gas, telephone, television, electric power, water, sewer, or irrigation system and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection thereof have been made by the CONTRACTOR.
7. Notify property owners and utility offices which may be affected by the construction operation at least 2 days in advance.
   a. Before exposing a utility, obtain utility owner's permission. Should service of utility be interrupted due to the CONTRACTOR's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
8. Do not impair operation of existing sewer systems. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures. Maintain original site drainage wherever possible.

B. Excavations Near Existing Gaslines:

1. Prior to any excavations, CONTRACTOR shall call Blue Stake at 263-1100 so the existing gas pipes may be accurately located. CONTRACTOR shall hand dig carefully at these marked locations until the gas pipe has been found and exposed. Use care to avoid damaging or breaking a small electrical tracer wire (which is used for locating purposes) that may be buried with the pipe.
2. Once mechanical trenching is in progress, CONTRACTOR shall not attempt to trench within 2 feet of a gas pipe. Trenching within 2 feet of a gas pipe shall be done by hand in order to prevent any damage to the gas pipe. If CONTRACTOR "hooks" or otherwise strains a gas pipe while excavating, a call shall be placed to 271-GASS (271-4277).

If a steel facility is exposed and the pipe coating is found to be in need of repair, CONTRACTOR shall contact the utility.

3. When the excavations are complete, CONTRACTOR shall protect all exposed gas pipes. If the trench is more than 3 feet wide, the pipe must be supported in a manner where the supporting material does not damage the pipe or its protective wrapping. CONTRACTOR shall call Southwest Gas at 484-5306 to review and approve all proposed pipe support designs.
4. Before backfilling the natural gas facilities, CONTRACTOR shall provide both 6 inches of bedding and 6 inches of shading with sand or material free of rocks and able to pass through a 3/8-inch screen in order to provide firm support under the facility and to prevent damage to the pipe or pipe coating from the backfilling operation. When backfilling, CONTRACTOR shall not drop backfill directly on the exposed gas pipe. When compacting backfill, CONTRACTOR shall use extra care when directly over the gas pipe in order to avoid any damage.

C. Barricades and Lights:

1. Provide as necessary to prevent unauthorized entry to construction areas and affected roads, streets, and alleyways, inside and outside of fenced area, and as required to ensure public safety and the safety of CONTRACTOR's employees, other employer's employees, and others who may be affected by the Work.
2. Provide to protect existing facilities and adjacent properties from potential damage.
3. Locate to enable access by facility operators and property owners.
4. Protect streets, roads, highways, and other public thoroughfares that are closed to traffic by effective barricades with acceptable warning signs.
5. Locate barricades at the nearest intersecting public thoroughfare on each side of the blocked section.

D. Signs and Equipment:

1. Conform to requirements of the manual published by the Arizona Department of Transportation and the City of Tempe Traffic Control and Barricade Manual.
2. Use to alert general public of construction hazards, which would include surface irregularities, unramped walkways, grade changes, and trenches or excavations in roadways and in other public access areas.

E. Tree and Plantings:

1. Protect from damage and preserve trees, shrubs, and other plants outside the limits of the Work and within the limits of the Work which are designated on the Drawings to remain undisturbed.
   a. Where practical, tunnel beneath trees when on or near the line of trench.
   b. Employ hand excavation as necessary to prevent tree injury.

c. Do not stockpile materials or permit traffic within drip lines of trees.
d. Provide and maintain temporary barricades around trees.
e. Water vegetation as necessary to maintain health.
f. Cover temporarily exposed roots with wet burlap, and keep the burlap moist until soil is replaced around the roots.
g. No trees, except those specifically shown on Drawings to be removed, shall be removed without written approval of the RESIDENT ENGINEER.
h. Dispose of removed trees in a legal manner off the site.

2. The balling and burlapping of trees indicated for replacement shall conform to the recommended specifications set forth in the American Standards for Nursery Stock, published by American Association of Nurserymen. All balls shall be firm and intact and made-balls will not be accepted. Handle ball and burlap trees by the ball and not by the top.
3. In the event of damage to bark, trunks, limbs, or roots of plants that are not designated for removal, treat damage by corrective pruning, bark tracing, application of a heavy coating of tree paint, and other accepted horticultural and tree surgery practices.
4. Replace each plant that dies as a result of construction activities.

F. Existing Structures: Where CONTRACTOR contemplates removal of small structures such as signposts, and culverts that interfere with CONTRACTOR's operations, obtain approval of property owner and RESIDENT ENGINEER. Replace those removed in a condition equal to or better than original.

G. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.

H. Dewatering: Construct, maintain, and operate cofferdams, channels, flume drains, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain, and operate necessary pumping and other equipment for the environmentally safe removal and disposal of water from the various parts of the Work. Maintain the foundations and parts of the Work free from water.

3.3 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations in accordance with the General Provisions.
2. Burning: Of waste materials, rubbish, or other debris will not be permitted on or adjacent to the site.
3. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in the construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.

4. Provide and maintain temporary dust-tight partitions, bulkheads, or other protective devices during construction to permit normal operation of existing facilities. Construct partitions of plywood, insulating board, plastic sheets, or similar material. Construct partitions in such a manner that dust and dirt from demolition and cutting will not enter other parts of existing building or facilities. Remove temporary partitions as soon as the need no longer exists.

B. Noise Control:

1. Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.
2. Noise Control Plans: Proposed plan to mitigate construction noise impacts and to comply with noise control ordinances including method of construction, equipment to be used, and acoustical treatments.

C. Water Pollution Control:

1. Divert sanitary sewage and nonstorm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to an existing waterway.
2. Prior to commencing excavation and construction, obtain OWNER's agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and stormwater flow, including dewatering pump discharges.
3. Comply with procedures outlined in U.S. Environmental Protection Agency manuals entitled, "Guidelines for Erosion and Sedimentation Control Planning" and "Implementation, Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activity," and "Erosion and Sediment Control—Surface Mining in Eastern United States."
4. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.
5. CONTRACTOR shall comply with the requirements of the Arizona Department of Environmental Quality State Water Quality Certification provided in the Appendix.

D. Damage to New Work:

1. CONTRACTOR shall protect all new Work and Work in progress from stormwater inflow into Salt River Channel from any and all underground storm drain pipes which outfall into the river at or upstream of the worksite location - worksite location being defined as the limits of the lake area. CONTRACTOR shall construct provide, maintain, and operate any and all temporary facilities necessary to control erosion and sediment associated with the stormwater flow in and throughout the aforementioned storm drain systems.

2. CONTRACTOR shall also be responsible for protecting or insuring against damage to new Work and Work in progress for stormwater flows in Salt River Channel and in Indian Bend Wash due to storm runoff or upstream water releases. CONTRACTOR shall be responsible for any and all loss or damage to new Work or Work in progress caused by flows originating upstream in the Salt River Channel or in Indian Bend Wash.
3. CONTRACTOR shall be required to obtain and maintain Builder Risk and Business Interruption insurance for the full term of the construction contract. Required insurance coverage shall include cost of replacing falsework, re-excavating worksite, and other actual damages to Work associated with this contract and shall also include home office or field office expenses and other expenses related to extended general conditions incurred by CONTRACTOR in conjunction with construction downtime due to unavailability of worksite resulting from sustained flows in the river channel.

3.4 STORAGE YARDS AND BUILDINGS

A. Coordinate requirements with Section 01600, MATERIAL AND EQUIPMENT.

B. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions.

C. Temporary Storage Buildings:

1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored.
2. Arrange or partition to provide security of contents and ready access for inspection and inventory.
3. Store combustible materials (paints, solvents, fuels, etc.) in a well-ventilated and remote building meeting safety standards.

3.5 ACCESS ROADS

A. Access to the construction areas is possible using the river bed and the existing gravel access roads that parallel both lake shores and are located at the top of the cement stabilized alluvium (CSA) and at the top of the levee. There are several existing ramps located on both sides of the lake that connect each of the access roads with the river bed. During flood releases, the river bed may not be available as an access route. In addition, construction activities as a result of the work by other contractors (Schedules A, C, and D) may result in one or more of the access roads being unavailable for extended (up to 3 months) period of time. CONTRACTOR is responsible for constructing any other required access roads within the easements, rights-of-way, or Project limits, as shown. Alignments for new routes must be approved by RESIDENT ENGINEER.

B. The existing bike paths shall be closed to bike traffic throughout the construction period except the bike path on the north side of the river between Scottsdale Road and the Indian Bend Wash drop structure shall

remain open unless construction operations make a temporary closure necessary. Closures shall be reviewed and approved by the City prior to implementation. CONTRACTOR shall not use the existing bike paths as access roads or operate any heavy equipment on the bike paths. CONTRACTOR shall not stockpile on top of any existing bike path. CONTRACTOR shall be responsible for protection of all bike paths in the event of any damage. CONTRACTOR shall repair the bike path in accordance with COT standards.

C. CONTRACTOR shall provide haul plan in accordance with the General Provisions.

D. Maintain drainage ways. Install and maintain culverts to allow water to flow beneath access roads. Provide corrosion-resistant culvert pipe of adequate strength to resist construction loads.

E. Provide gravel, crushed rock, or other stabilization material to permit access by all motor vehicles at all times.

F. Maintain road grade and crown to eliminate potholes, rutting, and other irregularities that restrict access.

G. Coordinate with RESIDENT ENGINEER detours and other operations affecting traffic and access. Provide at least 72 hours' notice to RESIDENT ENGINEER of operations that will alter access to the site.

H. Upon completion of construction, restore ground surface disturbed by access road construction to original grade. Replace damaged or broken culverts with new culvert pipe of same diameter and material.

3.6 PARKING AREAS

A. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, OWNER's operations, or construction operations.

B. Provide parking facilities for personnel working on the Project.

3.7 VEHICULAR TRAFFIC

A. Comply with Laws and Regulations regarding closing or restricting the use of public streets or highways. No public or private road shall be closed, except by written permission of the proper authority. Assure the least possible obstruction to traffic and normal commercial pursuits.

B. Conduct Work to interfere as little as possible with public travel, whether vehicular or pedestrian.

C. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.

D. In making street crossings, do not block more than one-half the street at a time. Whenever possible, widen the shoulder on the opposite side to facilitate traffic flow. Provide temporary surfacing on shoulders as necessary.

E. Maintain top of backfilled trenches before they are paved, to allow normal vehicular traffic to pass over. Provide temporary access driveways where required. Cleanup operations shall follow immediately behind backfilling.

F. When flaggers and guards are required by regulation or when deemed necessary for safety, furnish them with approved orange wearing apparel and other regulation traffic control devices.

G. Notify the fire department and police department before closing street or portion thereof. Notify said departments when streets are again passable for emergency vehicles. Do not block off emergency vehicle access to consecutive arterial crossings or dead-end streets, in excess of 300 linear feet, without written permission from the fire department. Conduct operations with the least interference to fire equipment access, and at no time prevent such access. Furnish CONTRACTOR's night emergency telephone numbers to the police department. All street closures must be approved by the City of Tempe Transportation Division.

H. Temporary Bridges:

1. Construct temporary bridges at all points where maintenance of traffic across pipeline construction is necessary.
2. Make bridges over public streets, roads, and highways acceptable to the authority having jurisdiction thereover.
3. Bridges erected over private roads and driveways shall be adequate for the service to which they will be subjected.
4. Provide substantial guardrails and suitably protected approaches.
5. Provide foot bridges not less than 4 feet wide with handrails and uprights of dressed lumber.
6. Maintain bridges in place as long as the conditions of the Work require their use for safety of the public, except that when necessary for the proper prosecution of the Work in the immediate vicinity of a bridge, the bridge may be relocated or temporarily removed for such period as the RESIDENT ENGINEER may permit.

I. Coordination: Coordinate traffic routing with that of others working in the same or adjacent areas.

3.8 CLEANING DURING CONSTRUCTION

A. In accordance with the General Provisions, as may be specified in Specification sections, and as required herein.

B. Wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, sweep all floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up all debris and dispose.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 1,175 feet above sea level.

B. Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of 10 degrees F to 130 degrees F.

1.5 PREPARATION FOR SHIPMENT

A. When practical, factory assemble products. Matchmark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with a strippable protective coating.

B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and CONTRACTOR, equipment number, and approximate weight. Include complete packing lists and bills of materials with each shipment.

C. Spare Parts, Special Tools, Test Equipment, Expendables, and Maintenance Materials:

1. Furnish as required by the Specifications prior to (i) starting functional testing as set forth in Section 01650, FACILITY STARTUP, or (ii) operation of the equipment by the OWNER, or (iii) 75 percent Project completion, whichever occurs first.
2. Properly package to avoid damage, in original cartons insofar as possible. Replace parts damaged or otherwise inoperable.
3. Firmly fix to, and prominently display on, each package.
   a. Minimum 3-inch by 6-inch manila shipping tag with the following information printed clearly:
      1) Manufacturer's part description and number.
      2) Applicable equipment description.
      3) Quantity of parts in package.
      4) Equipment manufacturer.
      5) Applicable Specification section.
      6) Name of CONTRACTOR.
      7) Project name.
4. Deliver materials to site.
5. Notify Resident Engineer.

D. Protect equipment from exposure to the elements and keep thoroughly dry and dustfree at all times. Protect painted surfaces against impact, abrasion, discoloration, or other damage. Grease or oil all bearings and similar items.

E. Request a minimum 7-day advance notice of shipment from manufacturers. Upon receipt of manufacturer's advance notice of shipment, promptly notify

ENGINEER of anticipated date and place of the arrival of rubber dam bladders and blowers.

F. Request a minimum 7-day advance notice of shipment from manufacturers. Upon receipt of manufacturer's advance notice of shipment, promptly notify ENGINEER of anticipated date and place of the arrival of recovery well pumps and motors.

G. Factory Test Results: Reviewed and accepted by ENGINEER before product shipment as required in individual Specification sections.

1.6 DELIVERY AND INSPECTION

A. Deliver products in accordance with the accepted current progress schedule and coordinate to avoid conflict with Work and conditions at the site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.

B. Deliver products in undamaged condition, in manufacturer's original container or packaging, with identifying labels intact and legible. Include on label date of manufacture and shelf life, where applicable. Include UL labels on products so specified.

C. Unload products in accordance with manufacturer's instructions for unloading, or as specified. Record the receipt of products at the site. Inspect for completeness and evidence of damage during shipment.

D. Remove damaged products from the site and expedite delivery of identical new undamaged products and remedy incomplete or lost products to provide that specified, so as not to delay the progress of the Work.

1.7 HANDLING, STORAGE, AND PROTECTION

A. Handle products in accordance with the manufacturer's written instructions, and in a manner to prevent damage. Store products, upon delivery, in accordance with manufacturer's instructions, with labels intact and legible, in approved storage yards or sheds provided in accordance with Section 01500, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by OWNER.

B. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered but not installed in the Work.

C. Store electrical, instrumentation, and control products, and equipment with bearings in weathertight structures maintained above 60 degrees F. Protect electrical, instrumentation, and control products, and insulation against moisture, water, and dust damage. Connect and operate continuously all space heaters furnished in electrical equipment.

D. Store fabricated products aboveground, on blocking or skids, and prevent soiling or staining. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

E. Store finished products that are ready for installation in dry and well ventilated areas. Do not subject to extreme changes in temperature or humidity.

F. Hazardous Materials: Prevent contamination of personnel, the storage building, and the site. Meet the requirements of the product specifications, codes, and manufacturer's instructions.

1.8 SUBSTITUTE AND "OR-EQUAL" PRODUCTS

A. Meet the requirements of the Specification sections, and as set forth herein.

B. Listing of proposed substitute or "or-equal" items or methods.

1. With consideration of the additional evaluation time necessary for ENGINEER's review of such items, indicate for each item the review status (either substitute or "or-equal") and estimated submission date.
2. CONTRACTOR, in indicating the review status of the proposed item, acknowledges that the time shown for ENGINEER's review on the current accepted schedule is sufficient only to allow ENGINEER to accomplish review for the status indicated and not sufficient to perform both a review for "or-equal" status and a subsequent review for substitute status on the same product.
3. ENGINEER may return unreviewed those submissions (i) not shown on the current accepted schedule, (ii) for which the review status differs from that indicated on the accepted list unless previously approved in writing by ENGINEER, (iii) not as specified herein, (iv) which are incomplete, or (v) which are uncertified, in which case CONTRACTOR shall provide the specified product.

C. Submit six copies of proposed substitute or "or-equal" item/method, to include all supporting data to allow ENGINEER's review. Complete, sign, and transmit with each proposed substitute or "or-equal" item/method submission.

D. Disposition of "Or-Equal" Item: In accordance with Article SHOP DRAWINGS in Section 01300, SUBMITTALS, or in accordance with following paragraph.

E. Disposition of Substitute Item/Method:

1. Accepted: ENGINEER will evidence such acceptance by recommendation of a Change Order for CONTRACTOR and OWNER execution. Such Change Order will accompany ENGINEER's evaluation and acceptance of CONTRACTOR's proposed substitute.
2. Rejected:

a. One copy retained by ENGINEER.
b. One copy returned to CONTRACTOR with a commentary by ENGINEER.
c. Remaining copies will be destroyed.
d. CONTRACTOR shall provide item specified in Contract Documents.

1.9 DEPARTMENT OF WATER RESOURCES

A. Formal signatory approval by Arizona Department of Water Resources Flood Warning and Dam Safety Section may be required for significant design changes.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide manufacturer's standard materials suitable for service conditions unless otherwise specified in the individual Specifications.

B. Where product specifications include a named manufacturer, with or without model number, and also include performance requirements, named manufacturer's products must meet the performance specifications.

C. Like items of products furnished and installed in the Work shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, and manufacturer's services and implement same or similar process instrumentation and control functions in same or similar manner.

D. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

E. Provide interchangeable components of the same manufacturer, for similar components, unless otherwise specified.

F. Equipment, Components, Systems, Subsystems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, state, and local health and safety regulations.

G. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16-gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated 1/2-inch mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.

H. Provide materials and equipment listed by UL wherever standards have been established by that agency.

I. Equipment Finish:

1. Provide manufacturer's standard finish and color, except where specific color is indicated.
2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.

J. Special Tools and Accessories: Furnish to OWNER, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, handwheels, chain operators, special tools, and other spare parts as required for maintenance.

K. Lubricant: Provide initial lubricant recommended by equipment manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by OWNER.

2.2 FABRICATION AND MANUFACTURE

A. General:

1. Manufacture parts to U.S.A. standard sizes and gauges.
2. Two or more items of the same type shall be identical, by the same manufacturer, and interchangeable.
3. Design structural members for anticipated shock and vibratory loads.
4. Use 1/4-inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
5. Modify standard products as necessary to meet performance Specifications.

B. Lubrication System:

1. Require no more than weekly attention during continuous operation.
2. Convenient and accessible. Oil drains with bronze or stainless steel valves and fill plugs easily accessible from the normal operating area or platform. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.
3. Provide constant-level oilers or oil level indicators for oil lubrication systems.
4. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

2.3 SOURCE QUALITY CONTROL

A. Calibration Instruments: Bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology (NIST).

B. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.

PART 3 EXECUTION

3.1 INSPECTION

A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage which necessitates procurement of new products will be considered delays within CONTRACTOR's control.

3.2 INSTALLATION

A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. No shimming between machined surfaces is allowed.

C. Install Work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Repaint painted surfaces that are damaged prior to equipment acceptance.

E. Handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's instructions and as may be specified. Retain a copy of manufacturers' instruction at site, available for review at all times.

F. For material and equipment specifically indicated or specified to be reused in the Work:

1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
2. Arrange for transportation, storage, and handling of products that require offsite storage, restoration, or renovation. Include costs for such Work in the Contract Price.

3.3 FIELD FINISHING

A. In accordance with Section 09900, PAINTING.

3.4 ADJUSTMENT AND CLEANING

A. Perform required adjustments, tests, operation checks, and other startup activities.

3.5 LUBRICANTS

A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by OWNER.

END OF SECTION

SECTION 01640
MANUFACTURERS' SERVICES

PART 1 GENERAL

1.1 DEFINITIONS

A. Reference Section 01650, FACILITY STARTUP.

B. Person-Day: One person for 8 hours within regular CONTRACTOR working hours.

1.2 SUBMITTALS

A. Training Schedule: Submit not less than 21 days prior to start of equipment installation and revise as necessary for acceptance.

B. Preliminary Training Plan: Submit within 60 days after Notice to Proceed.

C. Final Training Plan: Submit after training coordination meeting.

D. Training Materials:

1. Submit written outlines of proposed training sessions not less than 21 days prior to scheduled training.
2. Furnish complete training materials, to include operation and maintenance data as required in this section to be retained by each trainee.

E. Quality Control Submittals: When specified in the individual Specifications, submit:

1. Qualifications of Manufacturer's Representative performing specified services.
2. Manufacturer's Certificate of Proper Installation: On form appended to this section.

1.3 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

A. Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system. Additional qualifications may be specified elsewhere.

B. Representative subject to acceptance by OWNER. No substitute representatives will be allowed unless prior written approval by OWNER has been given.

1.4 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. Where manufacturers' services are specified, furnish manufacturer's qualified representative. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, additional time required to perform the specified services shall be considered incidental work.

B. Schedule manufacturer's services to avoid conflicting with other onsite testing or other manufacturer's onsite services. Determine that all conditions necessary to allow successful testing have been met before scheduling services.

C. Only those days of service approved by RESIDENT ENGINEER will be credited to fulfill the specified minimum services.

D. If specified, manufacturer's onsite services shall include as a minimum:

1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of CONTRACTOR's assembly, erection, installation or application procedures.
2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish written approval of installation.
3. Revisiting the site as required to correct problems and until installation and operation are acceptable to RESIDENT ENGINEER.
4. Resolution of assembly or installation problems attributable to, or associated with, respective manufacturer's products and systems.
5. Assistance during functional and performance testing and startup demonstration, and until product acceptance by the OWNER.
6. Training of OWNER's personnel in the operation and maintenance of respective product as required.
7. Completion of Manufacturer's Certificate of Proper Installation (form enclosed at end of this section) with applicable certificates for proper installation and initial, interim, and final test or service.
8. Additional requirements may be specified elsewhere.

1.5 TRAINING SCHEDULE

A. List specified equipment and systems with respective manufacturers that require training services of manufacturers' representatives and show:

1. Estimated dates for installation completion.
2. Estimated training date. This training session shall be videotaped by CONTRACTOR for use by OWNER in conducting future training sessions.

B. Adjust training schedule to ensure training of appropriate personnel as deemed necessary by OWNER, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.

C. Coordinate with Section 01310, PROGRESS SCHEDULES and Section 01650, FACILITY STARTUP.

1.6 TRAINING OWNER'S PERSONNEL

A. Furnish trained, articulate personnel to coordinate, expedite, and videotape training, to be present during training coordination meetings with OWNER, and familiar with operation and maintenance manual information specified in Section 01430, OPERATION AND MAINTENANCE DATA.

B. Furnish manufacturers' representatives for detailed classroom and hands-on training to OWNER's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.

1. Manufacturer's Representative: Familiar with facility operation and maintenance requirements as well as with specified equipment.

C. Prestartup Training:

1. Coordinate training sessions with OWNER's operating personnel and manufacturers' representatives, and with submission of operation and maintenance manuals in accordance with Section 01430, OPERATION AND MAINTENANCE DATA.
2. Complete at least 14 days prior to actual startup.

D. Post-Startup Training: If required in Specifications, furnish and coordinate training of OWNER's operating personnel by respective manufacturer's representatives.

1.7 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION", are part of this Specification.

1. Forms: Manufacturer's Certificate of Proper Installation.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER_____ EQPT SERIAL NO.:_____

EQPT TAG NO.:_____ EQPT/SYSTEM:_____

PROJECT NO.:_____ SPEC. SECTION:_____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- ☐ Installed in accordance with Manufacturer's recommendations.
- ☐ Inspected, checked, and adjusted.
- ☐ Serviced with proper initial lubricants.
- ☐ Electrical and mechanical connections meet quality and safety standards.
- ☐ All applicable safety equipment has been properly installed.
- ☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Comments:_____

_____

_____

_____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date:_____, 19____

Manufacturer:_____

By Manufacturer's Authorized Representative:_____

(Authorized Signature)

SECTION 01650
FACILITY STARTUP

PART 1 GENERAL

1.1 DEFINITIONS

A. Reference Section 01640, MANUFACTURERS' SERVICES.

B. Facility Startup: Includes putting Project in operating order, cleaning, adjusting and balancing equipment, initial operation (startup) of equipment item, operating equipment, starting systems, operation of systems, testing of equipment and systems, and demonstration and verification of the completed facility as a unit.

C. Functional Test: A test or tests in the presence of the DESIGN ENGINEER, RESIDENT ENGINEER, and OWNER to demonstrate that the installed equipment or system meets manufacturer's installation and adjustment requirements and other requirements specified including, but not limited to, noise, vibration, alignment, speed, proper electrical and mechanical connections, thrust restraint, proper rotation, and initial servicing.

D. Performance Test: A test performed in the presence of the DESIGN ENGINEER, RESIDENT ENGINEER, and OWNER and after any required functional test specified, to demonstrate and confirm that the equipment and/or system meets the specified performance requirements.

E. Significant Interruption: May include any of the following events:

1. Failure of CONTRACTOR to maintain qualified onsite startup personnel as scheduled
2. Failure to meet specified performance for more than 2 consecutive hours.
3. Failure of any critical equipment unit, system, or subsystem that is not satisfactorily corrected within 5 hours after failure.
4. Failure of noncritical unit, system, or subsystem that is not satisfactorily corrected within 8 hours after failure.
5. As may be determined by DESIGN ENGINEER.

F. Startup Test Period:

1. Startup of the entire facility or any portion thereof includes coordinated operation of the facilities by the CONTRACTOR, Subcontractors, OWNER operating personnel, and manufacturer's representatives for equipment items and systems after all required functional tests have been completed and those performance tests deemed necessary for the safe operation of the entire facility have been completed.
2. Startup of the entire facility or any portion thereof shall be considered complete when, in the opinion of DESIGN ENGINEER, the facility

or designated portion has operated in the manner intended for 5 continuous days without significant interruption. This period is in addition to any training, functional, or performance test periods specified elsewhere. A significant interruption will require the startup then in progress to be stopped and restarted after corrections are made.

G. System: The overall process, or a portion thereof, that performs a specific function. A system may consist of two or more subsystems as well as two or more types of equipment. Examples of systems on this Project are as follows:

1. Rubber dams.
2. Instrumentation and control system(s).
3. Aeration/mixing system.

1.2 SUBMITTALS

A. Administrative Submittals:

1. Functional and performance test schedules and plan for equipment, units, and systems at least 14 days prior to start of related testing. Include test plan, procedures, and log format.
2. Schedule and plan of facility startup activities at least 21 days prior to commencement.

B. Quality Control Submittals:

1. Manufacturer's Certificate of Proper Installation as required.
2. Test Reports: Functional and performance testing, in format acceptable to DESIGN ENGINEER and certification of functional and performance test for each piece of equipment or system specified.
3. Certifications of Calibration: Testing equipment.

1.3 CONTRACTOR FACILITY STARTUP RESPONSIBILITIES

A. General:

1. Perform Work for tests specified.
2. Demonstrate proper installation, adjustment, function, performance, and operation of equipment, systems, control devices, and required interfaces individually and in conjunction with process instrumentation and control system.

1.4 OWNER/DESIGN ENGINEER FACILITY STARTUP RESPONSIBILITIES

A. General:

1. Review CONTRACTOR's test plan and schedule.
2. Witness each functional or performance test.
3. Coordinate other plant operations, if necessary, to facilitate CONTRACTOR's tests.

4. Provide water, power, chemicals, and other items as required for testing, unless otherwise indicated.

B. Startup Test Period:

1. Operate process units and devices, with support of CONTRACTOR.
2. Provide sampling, labor, and materials as required and provide laboratory analyses.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 TESTING PREPARATION

A. General:

1. Complete Work associated with the unit and related processes before testing, including related manufacturer's representative services.
2. Furnish qualified manufacturer's representatives when required to assist in testing.
3. Utilize the Manufacturer's Certificate of Proper Installation Form from Section 01640, MANUFACTURERS' SERVICES, supplemented as necessary, to document functional and performance procedures, results, problems, and conclusions.
4. Schedule and attend pretest (functional and performance) meetings related to test schedule, plan of test, materials, chemicals, and liquids required, facilities' operations interface, DESIGN ENGINEER and OWNER involvement.
5. Designate and furnish one or more persons to be responsible for coordinating and expediting CONTRACTOR's facility startup duties. The person or persons shall be present during facility startup meetings and shall be available at all times during the facility startup period.
6. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required to conduct testing.

B. Cleaning and Checking: Prior to starting functional testing:

1. Calibrate testing equipment for accurate results.
2. Inspect and clean equipment, devices, connected piping, and structures so they are free of foreign material.
3. Lubricate equipment in accordance with manufacturer's instructions.
4. Turn rotating equipment by hand and check motor-driven equipment for correct rotation.
5. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
6. Check power supply to electric-powered equipment for correct voltage.
7. Adjust clearances and torques.
8. Test piping for leaks.
9. Balance HVAC systems, measuring airflow (cfm) static pressure, and component pressure losses. Furnish typed report documenting results of balancing.

10. Obtain completion of applicable portions of Manufacturer's Certificate of Proper Installation in accordance with Section 01640, MANUFACTURERS' SERVICES.

C. Ready-to-test determination will be by DESIGN ENGINEER based at least on the following:

1. Notification by CONTRACTOR of equipment and system readiness for testing.
2. Acceptable testing plan.
3. Acceptable Operation and Maintenance Manuals.
4. Receipt of Manufacturer's Certificate of Proper Installation, if specified.
5. Adequate completion of Work adjacent to, or interfacing with, equipment to be tested.
6. Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
7. Equipment and electrical tagging complete.
8. All spare parts and special tools delivered to OWNER.

3.2 FUNCTIONAL TESTING

A. General:

1. Begin testing at a time mutually agreed upon by the OWNER, DESIGN ENGINEER, manufacturer's representative(s), and CONTRACTOR.
2. Notify in writing OWNER, DESIGN ENGINEER, and manufacturer's representative at least 10 days prior to scheduled date of functional tests.
3. Separate items of equipment demonstrated to function properly during subsystem testing may require no further functional test if documentation of subsystem testing is acceptable to DESIGN ENGINEER.
4. Conduct functional test until each individual component item or system has achieved 1 continuous hour of satisfactory operation. Demonstrate all operational features and controls function during this period while in automatic modes.
5. If, in DESIGN ENGINEER's opinion, each system meets the functional requirements specified, such system will be accepted as conforming for purposes of advancing to performance testing phase, if required. If, in DESIGN ENGINEER's opinion, functional test results do not meet requirements specified, the systems will be considered as nonconforming.
6. Performance testing shall not commence until the equipment or system meets functional tests specified.

3.3 PERFORMANCE TESTING

A. General:

1. Begin testing at time mutually agreed upon by the OWNER, DESIGN ENGINEER, manufacturers' representative(s), and CONTRACTOR, as appropriate.
   a. DESIGN ENGINEER will be present during test.
   b. Notify DESIGN ENGINEER and OWNER at least 14 days prior to scheduled date of test.
2. Follow approved testing plan and detailed procedures specified.
3. Source and type of fluid, gas, or solid for testing shall be as specified.
4. Unless otherwise indicated, furnish all labor, materials, and supplies for conducting the test and taking all samples and performance measurements.
5. Prepare performance test report summarizing test method. Include test logs, pertinent calculations, and certification of performance.

3.4 STARTUP TEST PERIOD

A. Test Reports: As applicable to the equipment furnished, certify in writing that:

1. Necessary hydraulic structures, piping systems, and valves have been successfully tested,
2. Equipment systems and subsystems have been checked for proper installation, started, and successfully tested to indicate that they are operational,
3. Systems and subsystems are capable of performing their intended functions,
4. Facilities are ready for intended operation.

B. Attend planning meetings and arrange for attendants by key major equipment manufacturer representatives as required by the Contract Documents.

C. Designate and furnish one or more persons to be responsible for coordinating and expediting CONTRACTOR's facility startup duties.

D. When facility startup has commenced, schedule remaining Work so as not to interfere with or delay the completion of facility startup. Support the facility startup activities with adequate staff to prevent delays and process upsets. This staff shall include, but not be limited to, major equipment and system manufacturers' representatives, Subcontractors, electricians, instrumentation personnel, millwrights, pipefitters and plumbers.

E. Supply and coordinate specified manufacturer's facility startup services.

F. Make adjustments, repairs, and corrections necessary to complete facility startup.

G. After the facility is operating, complete the testing of those items of equipment, systems, and subsystems which could not be or were not adequately or successfully tested prior to startup test period.

3.5 PARTIAL UTILIZATION

A. After successful performance testing of a particular equipment type or system, OWNER may elect to start up a portion of the equipment or system for continuous operation. Such operation will not interfere with testing of other equipment and systems that may still be underway, and shall not preclude the need to startup that portion operated in combination with the rest of the facility when testing is completed.

3.6 CONTINUOUS OPERATIONS

A. OWNER will accept equipment and systems as substantially complete and ready for continuous operation only after successful facility startup is completed and documented, and reports submitted, and manufacturers' services completed for training of OWNER's personnel.

END OF SECTION

SECTION 01700
CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 SUBMITTALS

A. Quality Control Submittals: Written procedures for maintaining and markup of record documents.

B. Contract Closeout Submittals: Submit prior to application for final payment.

1. Record Documents.
2. Approved Shop Drawings and Samples.
3. Special Bonds, Special Warranties, and Service Agreements.
4. Consent of Surety to Final Payment.
5. Releases or Waivers of Liens and Claims.
6. Releases from Agreements.
7. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01025, MEASUREMENT AND PAYMENT.
8. Spare Parts and Special Tools: As required by individual specification sections.

1.2 RECORD DOCUMENTS

A. Quality Assurance:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
2. Accuracy of Records:
   a. Coordinate changes within record documents, making legible and accurate entries on each page of Specifications and each sheet of Drawings and other documents where such entry is required to show change.
   b. Purpose of Project record documents is to document factual information regarding aspects of Work, both concealed and visible, to enable future modification of Work to proceed without lengthy and expensive site measurement, investigation, and examination.
3. Make entries within 24 hours after receipt of information that a change in Work has occurred.
4. Prior to submitting each request for progress payment, request RESIDENT ENGINEER's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a referral by RESIDENT ENGINEER to recommend the whole or any part of the CONTRACTOR's Application for Payment, either partial or final.

1.3 RELEASES FROM AGREEMENTS

A. Furnish OWNER written releases from property owners or public agencies where side agreements or special easements have been made, or where CONTRACTOR's operations have not been kept within the OWNER's construction right-of-way.

B. In the event CONTRACTOR is unable to secure written releases, inform the OWNER of the reasons:

1. OWNER or its representatives will examine the site, and OWNER will direct CONTRACTOR to complete Work that may be necessary to satisfy terms of the easement.
2. Should CONTRACTOR refuse to perform this Work, OWNER reserves the right to have it done by separate contract and deduct the cost of same from the Contract Price, or require the CONTRACTOR to furnish a satisfactory Bond in a sum to cover legal claims for damages.
3. When OWNER is satisfied that Work has been completed in agreement with the Contract Documents and terms of easements, the right is reserved to waive the requirement for written release if: (i) CONTRACTOR's failure to obtain such statement is due to the grantor's refusal to sign, and this refusal is not based upon any legitimate claims that CONTRACTOR has failed to fulfill the terms of the easement, or (ii) CONTRACTOR is unable to contact or has had undue hardship in contacting the grantor.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 MAINTENANCE OF RECORD DOCUMENTS

A. General:

1. Promptly following commencement of Contract Times, secure from RESIDENT ENGINEER at no cost to CONTRACTOR, one complete set of Contract Documents. Drawings will be full size.
2. Delete RESIDENT ENGINEER title block and seal from all documents.
3. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large printed letters.
4. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.

B. Preservation:

1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
2. Make documents and Samples available at all times for observation by RESIDENT ENGINEER.

C. Making Entries on Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
   a. Color Coding:
      1) Green when showing information deleted from Drawings.
      2) Red when showing information added to Drawings.
      3) Blue and circled in blue to show notes.
2. Date entries.
3. Call attention to entry by "cloud" drawn around area or areas affected.
4. Legibly mark to record actual changes made during construction, including, but not limited to:
   a. Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
   b. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.
   c. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
   d. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
   e. Changes made by Addenda Change Order, Written Amendment, and RESIDENT ENGINEER's written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
5. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
   a. Clearly identify the item by accurate note such as "cast iron drain," "galv. water," and the like.
   b. Show, by symbol or note, vertical location of item ("under slab," "in ceiling plenum," "exposed," and the like).
   c. Make identification so descriptive that it may be related reliably to Specifications.
6. Specifications: Legibly mark and record for each product the description of actual product installed if differs from that specified, including:
   a. Manufacturer, trade name, and catalog model number of each product and item of equipment actually installed.

3.2 FINAL CLEANING

A. Immediately prior to CONTRACTOR's notice of completion, clean entire site or parts thereof, as applicable.

1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to OWNER and RESIDENT ENGINEER.

2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
3. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
4. Broom clean exterior paved driveways and parking areas.
5. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
6. Rake clean all other surfaces.
7. Leave water courses, gutters, and ditches open and clean.

B. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

END OF SECTION

SECTION 02050
DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Portions of structures and other areas scheduled for selective demolition, partial demolition, and remodeling work are as shown.

1.2 SUBMITTALS

A. Quality Control Submittals:

1. Schedule of demolition, as part of and consistent with the progress schedule specified in Section 01310, PROGRESS SCHEDULES.
2. Methods of demolition and equipment proposed to demolish each structure and cement stabilized alluvium (CSA).
3. Copies of any authorizations and permits required to perform Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

A. Utilities: Notify OWNER or appropriate utilities to turn off affected services before starting demolition.

3.2 DEMOLITION

A. Drawings define minimum portion of structures and cement stabilized alluvium (CSA) to be removed. Unless otherwise shown, rough cuts or breaks may be made exceeding limits of demolition shown.

B. Exposed surface cut of CSA shall be uniform, straight, and a minimum of 4-inch depth perpendicular to CSA surface. Rough cut chipping may be used below saw cut depth.

C. Remove damaged CSA to satisfaction of RESIDENT ENGINEER and protect remaining CSA. Replace damaged CSA with concrete.

D. Upstream and Downstream Dam CSA Removal: Remove existing CSA-sloped embankment in its entirety within the limits shown for abutment construction.

E. Upstream Dam Cement Stabilized Alluvium (CSA) Surface Demolition:

1. OWNER will survey and set stakes for the North Shore and South Shore control lines.
2. CONTRACTOR shall remove alluvium fill and loose CSA.

3. RESIDENT ENGINEER and CONTRACTOR will review alignment and determine offset to true breakpoint of CSA slope.
4. RESIDENT ENGINEER and CONTRACTOR will determine breakpoint of CSA excavation and approximate slope. Breakpoint and slope will be dependent upon the assessed condition of the CSA at that location.
5. CONTRACTOR shall remove CSA as required to the depth of firm, dense CSA. Firm, dense CSA shall be defined as follows:
   a. Uniform in appearance.
   b. No loose particles.
   c. Minimum reading correlating to 1,000 psi compressive strength when tested by a Rebound Hammer in accordance with ASTM C805-85. Test at approximately 8 feet 0 inch on center each way.
   d. Correlate Rebound Hammer test with one set of three concrete cylinders cored at each abutment in accordance with ASTM C42-90 and tested in accordance with ASTM C39-93.
6. Removal shall be a minimum of 4 inches into firm, dense CSA.
7. Removal method shall not fracture, crack, or otherwise damage CSA that is to remain in place.
8. Surface of firm, dense CSA shall be pressure washed to facilitate bonding with the new concrete. Pressure washing shall be at a minimum of 1,500 psi water pressure.
9. Cuts at the boundaries on the CSA shall be sawed a minimum of 4 inches deep to create a uniform straight edge. Rough cut chipping may be used below the saw cut depth.
10. If depth of removal exceeds 2 feet 0 inch, remove CSA full depth.

F. CSA Grade Control Structure Removal:

1. Remove top of existing grade control structure down to elevation shown.
2. The grade control structure was constructed in approximately 12-inch lifts. Remove CSA to a depth greater than shown as necessary to next lower lift interface.
3. Partial lifts of CSA shall be broken off when vertical, relatively straight, surfaces.
4. Remaining surface of CSA shall be rough with 1/2-inch minimum amplitude.

G. Chain Link Fence: Remove chain link fence at Downstream Dam.

3.3 DISPOSAL

A. Dispose of cement stabilized alluvium, debris, and other nonsalvaged materials offsite in licensed landfills. Disposal of demolition material in the river channel is prohibited.

3.4 BACKFILLING

A. Demolished Areas: Backfill to existing ground level or foundation level of new construction.

B. Backfill Material and Compaction:

1. Conform to Section 02220, FILL AND BACKFILL, for earth materials.
2. Do not use demolition debris as backfill material.
3. Where existing CSA is removed to a depth greater than the limits shown, backfill with concrete having the same minimum compressive strength as the structure to be constructed. Pour monolithic with the structure.

3.5 SALVAGE

A. Equipment and materials within the limits of demolition, unless otherwise specified, will become the property of the CONTRACTOR.

END OF SECTION

SECTION 02100
SITE PREPARATION

PART 1 GENERAL

1.1 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2 inches caliper to a depth of 12 inches below subgrade.

D. Stripping: Removal of topsoil remaining after applicable scalping is completed.

E. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.2 SCHEDULING AND SEQUENCING

A. Prepare site only after adequate erosion and sediment controls are in place.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

A. Clear, grub, and strip areas actually needed for site improvements within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

C. Identify location on ground surface where all existing underground utilities are present.

3.2 LIMITS

A. As follows:

1. Excavation: 5 feet beyond top of cut slopes.
2. Waste Disposal:
   a. Clearing: 5 feet beyond perimeter.
   b. Scalping and Stripping: Not required.
   c. Grubbing: Around perimeter as necessary for neat finished appearance.

3. Structures: 15 feet outside of new structures.

B. Remove rubbish, trash, and junk from entire area within Project limits before starting Work on improvements.

3.3 DISPOSAL

A. Clearing and Grubbing Debris: Dispose of debris offsite.

B. Rubbish, Trash: Dispose of offsite.

END OF SECTION

SECTION 02140
DIVERSION AND CARE OF WATER

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers the Work necessary for removal of water from Work areas, diversion of river flow, and handling and removal of all other water during the entire construction period, complete.

B. CONTRACTOR shall control surface and groundwater to pretest completed Work and shall repair or replace all damage. Rainfall and river flows are unpredictable.

1.2 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of this section.

B. Weather Monitoring and Flood Warning Plan: Flood warning and weather advisory services are available through the Salt River Project, Flood Control District of Maricopa County, Arizona Department of Water Resources, and the National Weather Services. CONTRACTOR shall be responsible for coordinating with these and other appropriate agencies on a regular and timely basis to obtain available flood warning information for the Salt River and Indian Bend Wash. CONTRACTOR shall prepare a weather monitoring and flood warning plan for approval by the City prior to initiating activities within the Salt River floodplain.

C. Diversion Plan: A water diversion and control plan shall be prepared which addresses the diversion of water in and under the Salt River around construction areas. Design of the diversion plan is the sole responsibility of CONTRACTOR. Prior to beginning any Work, and within 45 days after award of contract, CONTRACTOR shall submit a draft copy of a Certificate of Design for the Diversion Plan with the seal of CONTRACTOR's engineer. This plan shall show proposed method for the diversion and care of water during construction. Following review by the DESIGN ENGINEER, OWNER, RESIDENT ENGINEER, and regulatory agencies, the comments shall be addressed and incorporated. The draft and final diversion plan shall be designed, stamped, signed, and certified by an independent professional consulting engineer, registered in the State of Arizona, who is not an employee of the CONTRACTOR. CONTRACTOR's engineer shall certify on a monthly basis that the diversion is constructed, operated, and maintained substantially in accordance with the design. System monthly certification shall be submitted on the 5th of each month.

D. Handling and Removal Plan: Prior to beginning any Work on handling and removal of water from excavations and foundations, CONTRACTOR shall

submit a draft Water Handling and Removal Plan Certificate of Design for the Water Handling and Removal Plan with the seal of CONTRACTOR's engineer as required for the Diversion Plan. The plan shall address the handling and removal of water from all sources that may impact construction. The Plan shall include descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply; pollution control facilities; discharge locations to be utilized; and provisions for immediate temporary water supply as required by this section. Drawings shall show locations, dimensions, and relationships of elements of each system. Design calculations shall be provided demonstrating adequacy of proposed dewatering systems and components. If the system is modified during installation or operation, revise or amend and resubmit Handling and Removal Plan. Design of the water handling and removal plan is the sole responsibility of CONTRACTOR. Water shall be removed so Work can be performed in the dry as specified. Following review of the draft plan by the DESIGN ENGINEER, OWNER, RESIDENT ENGINEER, and regulatory agencies, comments shall be incorporated and a final plan submitted. The plan shall show proposed method for removal and disposal of water from excavations and foundations. The draft and final handling and removal plans shall be designed, stamped, signed, and certified by an independent professional consulting engineer registered in the State of Arizona, who is not an employee of the CONTRACTOR. CONTRACTOR's engineer shall certify on a monthly basis that the handling and removal of water is constructed, operated, and maintained substantially in accordance with the design. Monthly certification shall be submitted by the 5th of each month.

E. Administrative Submittals:

1. Well permits.
2. Water discharge permits if required.

F. Quality Control Submittals:

1. Water Level Elevations Observed in Observation Wells: Submit same day measured.

1.3 CODES, ORDINANCES, AND STATUTES: CONTRACTOR shall familiarize themselves with, and comply with, all applicable, codes, ordinances, statutes, and bear sole responsibility for the penalties imposed for noncompliance. CONTRACTOR shall allow 6 weeks to have the Diversion Plan and Handling and Removal Plan reviewed by the DESIGN ENGINEER, RESIDENT ENGINEER, OWNER, and state and local agencies, and shall include the time for this review in his construction schedule.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL MANAGEMENT OF RIVER FLOWS

A. CONTRACTOR shall construct and maintain all specified and necessary cutoffs, cofferdams, channels, flumes, drains, sumps, wells, pumps, and/or other temporary diversion and protection works necessary for diversion and handling and removal of all water to properly accomplish Work. Construct diversion across the river channel upstream of the facilities under construction in accordance with all Drawings and as necessary to protect the Work. Control facilities shall extend vertically and laterally so as to cut off flow into the excavation so the foundation of the dams can be excavated and the Work constructed in the dry.

B. CONTRACTOR shall conform to the regulations of the local and state agencies pertaining to passing the natural flow of the Salt River through the construction site and for measures necessary to do Work on the existing levees.

C. Gap in the CSA Levees: If CONTRACTOR creates a gap in the existing levees for the purpose of construction of new facilities, the gap shall be constructed and filled as indicated in the approved Diversion Plan.

3.2 PASSING WATER OVER COMPLETED FACILITIES

A. Temporarily passing water over completed or partially completed portions of the facilities will be permitted, provided that completed Work is protected from erosion with riprap or other materials and further protected from erosion and contamination approved by CONTRACTOR's Engineer. Facilities over which flow has temporarily passed shall be cleaned up, contaminated material removed and facilities repaired and suitably prepared to receive the next phase of Work solely at CONTRACTOR's expense. The Diversion Plan and Handling and Removal Plan shall clearly address how completed Work will be protected and prepared for the next phase. All repair shall be completed to the satisfaction of the OWNER.

3.3 DEWATERING SYSTEMS

A. For the upstream and downstream dam foundations and other facilities covered by this Project, dewatering systems shall include cutoff walls, wells, or well points, and other equipment and appurtenances installed outside structural limits and sufficiently below lowest point of excavation to complete the Work. Groundwater shall be maintained at least 2 feet below the lowest point of excavation or deeper as required to achieve specified compaction.

B. Design and Operate Dewatering Systems:

1. To prevent settlement of ground as water is removed.
2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
3. To relieve artesian pressures and resultant uplift of excavation bottom.

4. To prevent damage to existing structures or those under construction.

C. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.

D. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.

E. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.

F. Drain or otherwise positively dewater borrow areas, embankment areas, structural excavations, trenches, foundation excavation, and other areas as necessary to permit satisfactory construction at all times. Where an excavation extends below the water table, dewatering shall be accomplished in a manner that will prevent loss of fines from the foundation, will maintain stability of the excavated slopes and bottom of the excavation, and will result in all construction operations being performed in the dry. The use of sufficient number of properly screened sumps, wells, or other equivalent methods will be necessary for dewatering. CONTRACTOR will also be required to control seepage along the bottom of the excavation, which may require pipe drains leading to sumps from which the water shall be pumped. Such pipe drains shall be of uniform diameter for each run, shall be provided with discharge connections and shall be embedded in reasonably well-graded gravel.

G. During the placing and compacting of the fill material, including roller compacted concrete (RCC) and construction of concrete structures, the water level at every point in the excavation shall be maintained at least 2 feet below the bottom of the excavation until the compacted material in the foundation excavation has reached a depth of 10 feet, after which the water level shall be maintained at least 10 feet below the top of the compacted embankment. When the fill has been constructed to an elevation above the stabilized water level without pumping, the pipe drains and sumps, including surrounding gravel, shall be completely filled with grout composed of water, cement, and 5 percent bentonite. The grout mix shall be acceptable to DESIGN ENGINEER. In no case shall a water cement ratio greater than 0.75 be used.

3.4 CLEANUP

A. After having served their purpose, all materials placed for temporary diversion and protection shall remain the property of CONTRACTOR and shall be removed from the site. Remove all cofferdams or other temporary diversion and protective features so as not to interfere in any way with the operation or usefulness of the river channel. Remove, level, and grade all cofferdams or other temporary diversion and protective works constructed and not a part of the permanent facilities to the extent necessary to prevent obstruction in any degree whatever the flow of water in conformance with the Plans.

3.5 SETTLEMENT

A. Monitoring Dewatering-Induced Settlement: Establish monuments for monitoring settlement at locations selected by RESIDENT ENGINEER. Monitor vertical movement of each settlement monument, relative to remote benchmark selected by RESIDENT ENGINEER, at frequency stated in CONTRACTOR's Handling and Removal Plan.

3.6 DISPOSAL OF WATER

A. Obtain discharge permit for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

D. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

3.7 PROTECTION OF PROPERTY

A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems including but not limited to reinjection wells, and infiltration trenches and cutoff walls necessary to prevent damage to existing facilities, completed Work, and adjacent property.

B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.

3.8 RESPONSIBILITY OF CONTRACTOR

A. CONTRACTOR shall be responsible for and shall repair at his expense any damage to the foundations, structures, or any other part of the work caused by natural floods, water, or failure of any part of the diversion or protective works. In the event the construction area is flooded, clean up and repair the damage and dry out or remove material in embankments deemed too wet or contaminated for proper fill material by RESIDENT ENGINEER, all at CONTRACTOR's expense. CONTRACTOR shall be responsible for, and shall repair at his expense, any damage to areas downstream of the construction site caused by failure of any part of the diversion or protective

work. CONTRACTOR shall inspect, monitor, and repair cofferdam and other diversion works to maintain them in safe condition.

END OF SECTION

SECTION 02164
CSA GRADE CONTROL ANCHORS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Placing drawings.
2. Bar details.
3. Grout mix.

B. Quality Control Submittals:

1. Grout test results.
2. Pullout test results.
3. Calibration data for pullout test load measurement system.

PART 2 PRODUCTS

2.1 DEFORMED BARS

A. ASTM A615-90, Grade 60 in accordance with Section 03210, REINFORCING STEEL.

B. Furnish full length with applicable bends.

2.2 ANCHOR GROUT

A. Composition:

1. Portland Cement: ASTM C150-89, Type II. Minimum cement content 752 pounds per cubic yard.
2. Sand: ASTM C33-90, fine aggregate, except 100 percent shall pass No. 8 sieve.
3. Water: Clean and free of deleterious substances.
4. Water reducer or superplasticizer admixtures in accordance with Section 03300, CAST-IN-PLACE CONCRETE.

B. Compressive Strength: Minimum 4,000 psi at 28 days.

C. Water-Cement Ratio: Range from 0.40 to 0.45 by weight.

D. Water Loss: Control bleeding by adding sand.

PART 3 EXECUTION

3.1 DRILLING

A. Anchor Locations, Elevations, Depths, and Orientation:

1. As shown, unless adjusted by RESIDENT ENGINEER subject to conditions encountered in field.
2. Final locations, elevations, and depths shall be within plus or minus 0.1 foot and final vertical orientations within plus or minus 5 degrees.

B. Method:

1. Coring, rotary drilling, or percussion-air-hammer type drilling.
2. Use water or air with sufficient moisture for dust control to remove cuttings.
3. Do not use rod dope, grease, or other lubricants in drilling operations.
4. Drill holes to Elevation 1108. DESIGN ENGINER will log holes.

C. Minimum Hole Diameter: Larger of following.

1. Hole diameter as shown.
2. 1-1/2 times bar diameter.
3. 1-1/2 times coupler/splice diameter.
4. As required to accommodate grout and vent tubes with bar centered in hole.

3.2 HOLE PREPARATION FOR ANCHOR INSTALLATION AND GROUTING

A. After completion of hole, wash sides of hole with nozzle that impinges water on sides of hole with sufficient velocity to remove loose or caked material from the hole.

B. Immediately prior to anchor installation, reflush hole with water if necessary to saturate surfaces, sound hole for compliance with required depth.

C. Prevent entry of unwanted debris into drilled holes until anchor installation and grouting is completed.

3.3 HOLE ABANDONMENT

A. If hole is rejected by RESIDENT ENGINEER, fill hole with grout as specified.

B. Drill new hole in location determined by RESIDENT ENGINEER.

3.4 BAR PREPARATION

A. Immediately prior to installation, remove dirt, grease, loose rust, or other deleterious substances from bar surfaces.

3.5 GROUT TUBE PREPARATION

A. Immediately prior to insertion, check grout tube with air or water to ensure that it is clear.

3.6 BAR INSTALLATION

A. Install each bar prior to grouting.

B. Rigidly support each bar centered in its hole during placement of grout and until grout sets. Provide metal or plastic centrafiers at 10-foot maximum vertical spacing.

C. Obtain RESIDENT ENGINEER's approval of installation prior to grouting.

3.7 GROUT TUBE INSTALLATION

A. Insert grout tube with its discharge end at bottom of hole.

B. Grout Tube Diameter: Minimum 1-inch.

3.8 PUMPING GROUT

A. Screen mixed grout prior to pumping through maximum 1/8-inch clear openings. Screen shall be easily accessible for inspection and cleaning.

B. Measure quantity of grout pumped within 0.1 cubic foot. Submit grout data for each bar to RESIDENT ENGINEER.

C. Pump grout at rates sufficient to fill annulus space around bar within working time of grout.

3.9 PLACING GROUT

A. Inject grout at bottom of hole, displacing air and water out of hole.

B. As grout tube is withdrawn, keep grout tube below grout surface until hole is completely filled, and continue pumping as tube is withdrawn.

3.10 TESTING GROUT

A. Perform the following tests and submit results:

1. Fluid Consistency:
   a. Determine time of efflux in accordance with CRD-C611-85.
   b. One test for each batch mixed.
2. Nonbleeding:
   a. Determine in accordance with ASTM C940-89.
   b. No surface bleed water present up to 4 hours.
   c. One test each day of grouting.
3. Shrinkage:
   a. Determine in accordance with CRD-C621-89.
   b. One test each day of grouting.

4. Compressive Strength:
   a. Determine compressive strength of grout cubes sampled and tested in accordance with CRD-C621-89.
   b. Minimum of one test per day and whenever proportion of mix is changed.

3.11 PULLOUT TESTS

A. Test 5 percent of anchors to verify adequate pullout resistance.

B. RESIDENT ENGINEER will determine which anchors shall be tested.

C. Test anchors after grout has achieved 4,000 psi compressive strength.

D. Apply test load in tension equal to 80 percent of yield strength of bar. Maintain load for minimum of 10 minutes. If bar moves while maintaining test load, or if application of full test load is not possible, anchor will be rejected.

E. Test Apparatus: Conform to ASTM D4435-84 for each of the following items.

   1. Loading system.
   2. Load transducer.
   3. Displacement transducer.
   4. Displacement transducer support.

F. Load measurement systems shall be calibrated by independent testing laboratory and accurate to within plus or minus 5 percent of actual load.

G. Method of load application shall not damage bar.

H. Install replacement anchors for each failed anchor at location determined by RESIDENT ENGINEER.

I. Retest one additional anchor bar for each failed bar in addition to number initially required.

END OF SECTION

SECTION 02205
EXCAVATION

PART 1 GENERAL

1.1 DEFINITIONS

A. Common Excavation: All excavation is unclassified. Excavation will consist of removal of all material required to complete the Work in accordance with the Contract Documents.

B. Influence Area: As defined in Section 02220, FILL AND BACKFILL.

C. Standard Specifications: As defined in Section 02220, FILL AND BACKFILL.

1.2 SUBMITTALS

A. Shop Drawings:

1. Excavation Plan, Detailing:
   a. Methods and schedule of excavation for dam foundations, abutments, and cutoff walls.
   b. Proposed locations of stockpiled excavated material.
   c. Proposed onsite and offsite spoil disposal sites.
   d. Reclamation of onsite spoil disposal areas.

1.3 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

1.4 WEATHER LIMITATIONS

A. Material excavated with high moisture content shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.5 SEQUENCING AND SCHEDULING

A. Demolition: Complete applicable Work specified in Section 02050, DEMOLITION, prior to excavating.

B. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 02100, SITE PREPARATION, prior to excavating.

C. Dewatering: Conform to applicable requirements of Section 02140, DIVERSION AND CARE OF WATER, prior to initiating excavation.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular fill, and similar items wherever applicable. Trim to neat lines where concrete is to be deposited against earth. Obtain DESIGN ENGINEER's approval of completed excavation bottom prior to placing backfill or concrete.

B. Do not overexcavate without written authorization of RESIDENT ENGINEER.

C. Remove or protect obstructions as shown and as specified in Section 01500, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS, Article PROTECTION OF WORK AND PROPERTY.

D. Furnish and install all shoring, sheeting, and bracing required to support adjacent earth banks and structures, and for the protection and safety of all personnel working in the excavations. All shoring, sheeting, and bracing shall conform to the requirements of the state or local agencies having jurisdiction over such matters.

3.2 TRENCH WIDTH

A. Minimum Width of Trenches: As described below, unless otherwise shown or specified.

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
   a. 6-inch Outside Diameter or Width and Less: 24 inches.
   b. Greater than 6-inch Outside Diameter or Width: Outside diameter of pipes, conduits, direct-buried cables, or duct banks plus 36 inches.
2. Multiple Pipes, Conduits, Direct-Buried Cables, and Duct Banks in Single Trench: Aggregate width of pipes, conduits, direct-buried cables, or duct banks, plus 4 inches between, plus 20 inches.
3. Increase trench widths by thickness of shoring.

B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.3 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown. Conform to applicable shoring and safety requirements of local, state, and federal regulations.

B. Remove stones and rock that exceed 3 inch in diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes. Protect

undisturbed soil in cut slopes from ravelling. Remove all disturbed material prior to placing backfill.

C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.

3.4 REMOVAL OF CEMENT STABILIZED ALLUVIUM (CSA)

A. Use cutting saws to set a straight line for removal of existing CSA or abutments. Use pneumatic cutting tools to remove CSA down to a hard, sound surface where shown. Comply with Section 02050, DEMOLITION.

3.5 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

D. Do not stockpile excavated material adjacent to trenches and other excavations unless excavation sideslopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.6 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are not needed for fill or backfill, in designated fill disposal areas. Material greater than 6 inches in diameter shall be disposed in designated cobble disposal area. Material placed in fill or cobble disposal area shall be placed and compacted in accordance with Section 211 of the Standard Specifications.

B. Dispose of debris resulting from removal of underground facilities as specified in Section 02050, DEMOLITION, for demolition debris.

C. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in the Special Provisions.

3.7 SITE SAFETY

A. CONTRACTOR shall be responsible for all safety procedures in trenches, excavations, and Work areas. CONTRACTOR shall comply with all

applicable laws and regulations. Maintain shoring systems or trim slopes to provide safe excavations to complete the Work.

END OF SECTION

SECTION 02215
SUBGRADE PREPARATION

PART 1 GENERAL

1.1 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 02220, FILL AND BACKFILL.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, excavation to grade, and scarification and compaction of subgrade.

C. Relative Compaction: As defined in Section 02220, FILL AND BACKFILL.

D. Subgrade: Layer of existing soil after completion of clearing and grubbing prior to placement of fill, roadway structure or base for floor slab.

E. Unsuitable Material: Subgrade material within the influence area of structures and pipelines determined by the RESIDENT ENGINEER to require overexcavation and replacement.

1.2 QUALITY ASSURANCE

A. Notify RESIDENT ENGINEER when subgrade is ready for compaction or whenever compaction is resumed after a period of extended inactivity.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.2 COMPACTION

A. Under Earthfill: Compact the upper 6 inches to minimum of 95 percent relative compaction. Moisture content shall be within 3 percent of optimum.

B. Under Granular Fill Under Structures: Compact the upper 6 inches to minimum of 95 percent relative compaction. Moisture content shall be within 3 percent of optimum moisture. On slopes steeper than 4 horizontal to 1 vertical, remove all loose or disturbed material to a depth approved by the RESIDENT ENGINEER. No compaction of undisturbed material is required if approved by RESIDENT ENGINEER.

3.3 CORRECTION

A. Soft or Loose Subgrade:

1. Adjust moisture content and recompact, or
2. Over excavate as specified in Section 02205, EXCAVATION, and replace with suitable material from the excavation, as specified in Section 02220, FILL AND BACKFILL.

B. Unsuitable Material: Over excavate as specified in Section 02205, EXCAVATION, and replace with suitable material from the excavation, as specified in Section 02220, FILL AND BACKFILL.

END OF SECTION

SECTION 02220
FILL AND BACKFILL

PART 1 GENERAL

1.1 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by RESIDENT ENGINEER.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

C. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, excavation to grade, and subgrade preparation.

D. Completed Course: A course or layer that is ready for next layer or next phase of Work.

E. Lift: Loose (uncompacted) layer of material.

F. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

G. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1. 1 foot outside outermost edge at base of foundations or slabs.
2. 1 foot outside outermost edge at surface of roadways or shoulder.
3. 0.5 foot outside exterior at spring line of pipes or culverts.

H. Borrow Material: Material from required excavations.

I. Selected Fill and Backfill Material: Materials from excavations that RESIDENT ENGINEER determines to be suitable for specific use.

J. Imported Material: Materials obtained from sources offsite, suitable for specified use.

K. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

L. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

M. Standard Specifications: When referenced in this section, shall mean Maricopa Association of Government Standard Specifications.

1.2 SUBMITTALS

A. Samples: Imported material taken at source.

B. Quality Control Submittals:

1. Catalog and manufacturer's data sheets for compaction equipment.
2. Certified test results from independent testing agency.

1.3 QUALITY ASSURANCE

A. Notify RESIDENT ENGINEER when:

1. Structure is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.4 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Sections 02050, DEMOLITION; 02100, SITE PREPARATION; 02205, EXCAVATION; and 02215, SUBGRADE PREPARATION, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03300, CAST-IN-PLACE CONCRETE. Obtain RESIDENT ENGINEER's acceptance of concrete work and attained strength prior to placing backfill.

C. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 02215, SUBGRADE PREPARATION.

PART 2 PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Gradation Tests:

1. As necessary to locate acceptable sources of imported material.
2. During production of imported material, test as follows:
   a. Granular Backfill: One per 50 cubic yards (minimum of two per structure).
   b. Aggregate Base Course Rock: One per 500 cubic yards (minimum of five).
   c. Foundation Stabilization Rock: One per 50 cubic yards (minimum of one).

B. Samples: Collected in accordance with ASTM D75-87:

1. During production of imported material, provide Samples as requested by RESIDENT ENGINEER.

2.2 EARTHFILL AND BACKFILL

A. Well-graded processed select fill and backfill excavated from required excavations free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials with less than 20 percent passing the No. 200 sieve.

B. Provide imported material of equivalent quality, if required to accomplish Work.

2.3 GRANULAR FILL

A. 2-inch minus well-graded onsite or imported silty sandy gravel or crushed rock with at least 30 percent of the material containing at least one fractured face. At upstream dam, under foundation slab and apron, granular fill need not have fractured faces.

B. Free from clay balls and organic material.

C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 30 percent and minimum of 15 by weight passing No. 200 sieve.

2.4 DRAIN GRAVEL

A. Clean, hard, durable gravel, free from foreign materials and washed.

B. Gradation as determined in accordance with ASTM C117-90 and C136-84a:

Sieve Size	Percent Passing by Weight
1.5-inch	100
3/4-inch	75-100
No. 4	20-50
No. 8	5-35
No. 30	0-10
No. 50	0-5
No. 200	0-3

2.5 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.6 AGGREGATE BASE COURSE (ABC)

A. As specified in Section 02236, BASE COURSE.

2.7 PIER SAND FILL

A. Well-graded, 3/8-inch minus, clean fill sand. ASTM C33-90.

PART 3 EXECUTION

3.1 GENERAL

A. Conform to Section 02215, SUBGRADE PREPARATION. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials. Perform dewatering in conformance with Section 02140, DIVERSION AND CARE OF WATER. Remove all loose material from existing CSA prior to placing fill. Break protrusions from CSA lifts and obtain DESIGN ENGINEER's approval prior to placing fill.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness not exceeding 8 inches loose, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure even.

D. 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.

E. Where the backfill material moisture content is too high to permit the indicated degree of compaction, the material shall be dried or thoroughly mixed with drier material until the moisture content is satisfactory.

F. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:

1. Fill or backfill to an elevation 2 feet above top of item to be laid.
2. Excavate trench for installation of item.
3. Install foundation stabilization rock and bedding, if applicable, as specified in Section 02225, TRENCH BACKFILL.
4. Install item.
5. Backfill envelope zone and remaining trench, as specified in Section 02225, TRENCH BACKFILL, before resuming filling or backfilling specified in this section.

G. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

H. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.2 BACKFILL UNDER AND AROUND STRUCTURES

A. Under Facilities: Within influence area beneath structures, slabs, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 8-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction. Moisture content shall be within 3 percent of optimum.

B. Drain Gravel: Backfill with drain gravel where shown as required in Section 03365, ROLLER COMPACTED CONCRETE.

C. Other Areas: If no other type of backfill is shown, backfill with earthfill to lines and grades shown, with proper allowance for surfacing where shown. Place in lifts of 8-inch maximum thickness and compact each lift to minimum 90 percent relative compaction.

3.3 EARTHFILL

A. Outside Influence Areas Beneath Structures, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:

1. Allow for surface restoration where required.
2. Maximum 8-inch thick lifts.
3. Place and compact fill across full width of fill area.
4. Compact to minimum 95 percent relative compaction.

5. Moisture content shall be within 3 percent of optimum.
6. Dress completed embankment with allowance for applicable surfacing and slope protection, where applicable.

3.4 PROTECTION OF COMPACTED SURFACES

A. Prior to placement of overlying fill, rebar, or concrete, remove all loose fill that does not conform to these Specifications. Apply shotcrete, wire fabric, or penetration liquid that maintains specified compaction until concrete or overlying fill is placed. CONTRACTOR shall demonstrate to RESIDENT ENGINEER that proposed methods will result in stabilization of fill slopes or surfaces. CONTRACTOR shall utilize additional measures if required by RESIDENT ENGINEER to provide compacted surface on which fill or concrete will be placed.

3.5 SITE TESTING

A. General:

1. RESIDENT ENGINEER will provide onsite quality assurance testing. CONTRACTOR shall provide sufficient quality control test to verify the Work meets the required specifications.
2. CONTRACTOR shall provide Samples of finishes provided as requested by RESIDENT ENGINEER.
3. CONTRACTOR shall prepare location for RESIDENT ENGINEER to perform field testing of the finished backfill.

B. Gradation:

1. One sample from each 500 cubic yards of finished product or more often as determined by RESIDENT ENGINEER, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

C. In-Place Density Tests: In accordance with ASTM D1556 or D2922. During placement of materials, test as follows:

1. Granular Fill: One per 20 cubic yards around structures, one per 300 cubic yards under upstream dam and downstream dam apron.
2. Drain Gravel: One per 50 cubic yards.
3. Foundation Stabilization Rock: One per 50 cubic yards.

3.6 AGGREGATE BASE

A. Place and compact as specified in Section 02236, BASE COURSE.

3.7 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by RESIDENT ENGINEER as follows:

1. Beneath Footings: Granular fill or concrete fill, as specified in Section 03300, CAST-IN-PLACE CONCRETE.
2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
3. Beneath Slabs-On-Grade: Granular backfill.
4. Trenches:
   a. Unauthorized Overexcavation: Either trench stabilization material or pipe bedding material, as specified in Section 02225, TRENCH BACKFILL.
   b. Authorized Overexcavation: Trench stabilization material, as specified in Section 02225, TRENCH BACKFILL.
5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
   a. Flat to Moderate Steep Slopes (3:1, Horizontal Run:Vertical Rise or Flatter): Earthfill.
   b. Steep Slopes (Steeper than 3:1):
      1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
      2) Backfilling overexcavated areas is prohibited unless, in RESIDENT ENGINEER's opinion, backfill will remain stable, and overexcavated material is replaced as compacted earth fill.
6. For overexcavation caused by the removal of unsuitable material, replace excavated material with earthfill, granular fill, or foundation stabilization rock to within 3 feet of original bottom of excavation. Place and compact material as specified for overlying material. Remaining overexcavation shall be backfilled as specified above.

3.8 GRAVEL SURFACING ROCK

A. Place and compact as specified in Section 02236, BASE COURSE.

END OF SECTION

SECTION 02225
TRENCH BACKFILL

PART 1 GENERAL

1.1 DEFINITIONS

A. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

B. Imported Material: Material obtained by the CONTRACTOR from source(s) offsite.

C. Lift: Loose (uncompacted) layer of material.

D. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

E. Prepared Trench Bottom: Graded trench bottom after stabilization and installation of bedding material.

F. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the RESIDENT ENGINEER.

G. Selected Backfill Material: Material available onsite that the RESIDENT ENGINEER determines to be suitable for a specific use.

H. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-Graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.2 SUBMITTALS

A. Shop Drawings: Manufacturer's descriptive literature for marking tapes.

B. Samples:

1. Trench stabilization material.
2. Bedding and pipe zone material.

C. Quality Control Submittals: Catalog and manufacturer's data sheets for compaction equipment.

1. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials,

except for trench stabilization material that will be submitted prior to material delivery to site.

PART 2 PRODUCTS

2.1 MARKING TAPE

A. Plastic:

1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 4 mils.
3. Width: 12 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
   a. Reef Industries; Terra Tape.
   b. Allen; Markline.

B. Metallic:

1. Solid aluminum foil, visible on unprinted side, encased in a protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 5.5 mils.
3. Width: 12 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Joining Clips: Tin or nickel-coated, furnished by tape manufacturer.
6. Manufacturers and Products:
   a. Reef Industries; Terra "D".
   b. Allen; Detectatape.

C. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities.

Color[a]	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Water, irrigation, and slurry lines
[a]As specified in ANSI Z53.1, Safety Color Code.	

2.2 TRENCH STABILIZATION MATERIAL

A. Clean, hard, durable 3-inch minus crushed rock or gravel, or pit run, free from clay balls, other organic materials, or debris.

B. Uniformly graded from coarse to fine, less than 8 percent by weight passing the 1/4-inch sieve.

2.3 PIPE BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Clean or gravelly sand, well graded, with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM C117 and C136, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.

1. Duct Banks: 3/4-inch maximum particle size.
2. Pipe Under 18 Inches Diameter: 3/4-inch maximum particle size, except 1/4-inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3 inches diameter.
3. Pipe Greater than 18 Inches Diameter: 1-1/2-inch maximum particle size for welded steel pipe.
4. Perforated Pipe: Drain rock.
5. Conduit and Direct-Buried Cable:
   a. Sand, clean or clean to silty, less than 12 percent passing the No. 200 sieve.
   b. Individual Particles: Free of sharp edges.
   c. Maximum Size Particle: Pass a No. 4 sieve.
   d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.
   e. For pipes and cables located in the river channel below the normal operating level, the bottom of the trench shall be checked by the DESIGN ENGINEER to determine if any backfill gradation changes are necessary. CONTRACTOR shall provide backfill material consistent with DESIGN ENGINEER's requirements.

2.4 TRENCH BACKFILL

A. Backfill above the pipe zone shall consist of excavated soil, 2-inch minus well graded silty sand and gravel with less than 10 percent passing the No. 200 sieve.

2.5 CONCRETE FILL AND BACKFILL

A. Provide as specified in Section 03300, CAST-IN-PLACE CONCRETE.

2.6 AGGREGATE BASE COURSE

A. As specified in Section 02236, BASE COURSE.

2.7 SOURCE QUALITY CONTROL

A. Perform gradation analysis in accordance with ASTM C136 for:

1. Trench stabilization material.
2. Bedding and pipe zone material.

PART 3 EXECUTION

3.1 TRENCH PREPARATION

A. Water Control:

1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.2 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify RESIDENT ENGINEER. RESIDENT ENGINEER will determine the depth of overexcavation, if any, required.

3.3 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.4 BEDDING

A. Furnish imported bedding material.

B. Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 inches.

C. Hand grade and compact each lift with a vibratory plate compactor to provide a firm, unyielding surface.

D. Minimum Thickness: As shown on Drawings or as follows:

1. Pipe, 15-Inch and Smaller: 4 inches.
2. Pipe, 18-Inch and Larger: 6 inches.
3. Conduit: 3 inches.
4. Direct-Buried Cable: 3 inches.

5. Duct Banks: 3 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1 to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.5 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:

1. Pipe: 12 inches, unless shown otherwise.
2. Conduit: 3 inches, unless shown otherwise.
3. Direct-Buried Cable: 3 inches, unless shown otherwise.
4. Duct Bank: 3 inches, unless shown otherwise.

B. Restrain and anchor pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Do not allow pipe zone material to free-fall into trench and cause damage to pipe or trench walls. Remove all materials from trench that do not conform to backfill materials.

D. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipes 10 Inches and Smaller Diameter: First lift less than or equal to 1/2 pipe-diameter.
2. Pipes Over 10 Inches Diameter: Maximum 6-inch lifts.

E. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift. Take care to make sure backfill material gets between and completely around pipes and duct banks before placing material above pipe.

F. Compact the material to a minimum 95 percent relative compaction as determined in accordance with ASTM D698. Compact only over the area between the sides of the pipe and the trench walls.

G. Do not use power-driven impact compactors to compact pipe zone material.

3.6 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of all buried piping, at depth of 2 feet below finished grade or top of backfill. Coordinate with piping installation drawings.

1. Metallic Marking Tape: Install with nonmetallic piping and waterlines.
2. Plastic Marking Tape: Install with metallic piping.

3.7 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to meet specified gradation requirements.
2. Adjust moisture content as necessary to obtain specified compaction.
3. Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for rock surfacing, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise shown or specified.
7. Place in lifts not exceeding 9-inch thickness.
8. Mechanically compact each lift to a minimum of 90 percent relative compaction prior to placing succeeding lifts.
9. Moisture content shall be within 3 percent of optimum.

B. Concrete Backfill:

1. Place above bedding.
2. Minimum Concrete Thickness: 6 inches on top and sides of pipe.
3. Do not allow dirt or foreign material to become mixed with concrete during placement.
4. Allow sufficient time for concrete to reach initial set before additional backfill material is placed in trench.
5. Prevent flotation of pipe.
6. Begin and end concrete backfill within 4 inches of a pipe joint on each end.
7. Do not encase pipe joints except within the limits of the concrete backfill.

3.8 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.

3.9 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 02236
BASE COURSE

PART 1 GENERAL

1.1 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform surface reasonably true to cross-section.

C. Standard Specifications: Uniform Standard Specifications for Public Works Construction, Maricopa Association of Government.

1.2 SUBMITTALS

A. Samples: Submit for specified materials 20 days prior to delivery to site.

B. Quality Control Submittals:

1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to project.

PART 2 PRODUCTS

2.1 BASE COURSE ROCK

A. As specified for crushed aggregate, aggregate base, in Section 702 of the Standard Specifications.

2.2 GRAVEL SURFACING ROCK

A. As specified in Section 702, of the Standard Specifications.

B. Clean, tough, uniform quality, durable fragments of crushed rock, free from flat, elongated, soft or disintegrated pieces, or other objectionable matter occurring either free or as coating on stone.

C. Physical Qualities: Same as for base course.

2.3 SOURCE QUALITY CONTROL

A. CONTRACTOR: Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on materials' test results on installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

A. As specified in Section 02215, SUBGRADE PREPARATION.

B. Obtain RESIDENT ENGINEER's acceptance of subgrade before placement of base course rock.

3.2 EQUIPMENT

A. Compaction Equipment: Adequate in design and number to provide compaction and obtain the specified density for each layer.

3.3 HAULING AND SPREADING

A. Hauling Materials:

1. Do not haul over surfacing in process of construction.
2. Loads: Of uniform capacity.
3. Measure capacity of truck to determine vehicle load and quantity.
4. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:

1. Distribute material to provide required density, depth, grade and dimensions with allowance for subsequent lifts.
2. Produce even distribution of material upon roadway without segregation.
3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.4 CONSTRUCTION OF COURSES

A. General: Complete each lift in advance of laying succeeding lift to provide required results and adequate inspection.

B. Base Course:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown.
3. Spread lift on preceding course to required cross-section.
4. Lightly blade and roll surface until thoroughly compacted.

5. Add keystone to achieve compaction and as required when aggregate does not compact readily due to lack of fines or natural cementing properties, as follows:
   a. Use leveling course or surfacing material as keystone.
   b. Spread evenly on top of crushed base course, using spreader boxes or chip spreaders.
   c. Roll surface until keystone is worked into interstices of crushed base course without excessive displacement.
   d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.
6. Blade or broom surface to maintain true line, grade, and cross-section.

C. Gravel Surfacing:

1. Maximum Completed Lift Thickness: 9 inches.
2. Completed Course Total Thickness: As shown.
3. Spread on preceding course in accordance with cross-section shown.
4. Blade lightly and roll surface until material is thoroughly compacted.

3.5 ROLLING AND COMPACTION

A. Rolling and Compaction: In accordance with Section 601.4, of the Standard Specifications.

3.6 SURFACE TOLERANCES

A. Finished Surface of Base Course: Within plus or minus 0.04 foot of grade shown at any individual point.

3.7 FIELD QUALITY CONTROL

A. In-Place Density Tests:

1. Construct base course so areas shall be ready for testing.
2. Show proof that areas meet specified requirements before requesting that RESIDENT ENGINEER identify density test locations.
3. Perform a minimum of one test on completed course per location in accordance with AASHTO T 191-86, T 205-86, or T 238-86 at locations acceptable to RESIDENT ENGINEER.

3.8 CLEANING

A. Remove excess material; clean stockpile areas of aggregate.

END OF SECTION

SECTION 02247
GEOSYNTHETIC CLAY LINING (GCL)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section covers the Work necessary to furnish and install geosynthetic clay lining (GCL) over the top of the cement bentonite cutoff wall complete.

B. GCL shall consist of a layer of domestic, natural, high swelling sodium bentonite clay encapsulated between two geotextiles. GCL shall be manufactured in a manner that holds the sodium bentonite clay between the geotextiles in a stable, uniform thickness that does not shift or become dislodged during handling.

1.2 QUALITY ASSURANCE QUALIFICATION

A. Submit a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the materials. The mill certificate or affidavit shall attest that GCL materials meet the chemical, physical, and manufacturing requirements stated in this Specification. Materials shall be the end products of one manufacturer in order to achieve standardization for performance, replacement, and maintenance.

1.3 DEFINITIONS

A. GCL: A flexible panel made of a layer of domestic, natural, high swelling sodium bentonite clay (montmorillonite) encapsulated between two geotextiles.

B. Geotextile: A woven or nonwoven permeable man-made textile used with geotechnical engineering-related materials.

C. Minimum Average Roll Value (MinARV): Minimum of a series of average roll values representative of the product furnished.

D. Maximum Average Roll Value (MaxARV): Maximum of a series of average roll values representative of the product furnished.

E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

1.4 SUBMITTALS

A. Complete material specifications including typical montmorillonite content by weight, typical moisture content, and water absorption by ASTM E946, Test Method for Water Absorption of Bentonite by Porous Plate Method.

B. Description of methods used to join the panel edges which will provide a seam that performs as effectively as the panels.

C. Listing of all exceptions to the requirements specified herein.

D. Factory test results of materials certified by the manufacturer as being similar. In addition, submit the manufacturer's certification that material furnished is similar and of the same formulation as that for which the test results are submitted.

E. Layout and installation drawings and procedures for carrying out the work.

F. On request, submit a sample of 2 square yards of the material from each shipment for verification and testing.

G. Complete description for handling and storage of the GCL and associated products including, but not limited to, methods of unloading, inspection, covered storage on pallets or in an enclosed storage facility, and recording the quantity and lot numbers for each package.

PART 2 PRODUCTS

2.1 GEOSYNTHETIC CLAY LINING

A. Panels of bentonite and encapsulating geotextiles manufactured to perform as a continuous lining. Panels shall contain 1 pound per square foot of high swelling sodium bentonite clay measured at a moisture content of 12 percent, or equivalent weight at other moisture content.

B. The active ingredient shall be a high quality natural sodium bentonite without chemical resistance enhancers or polymers. The bentonite shall be 92 percent typical montmorillonite content by weight when tested with x-ray diffraction methods. The bentonite shall have a minimum volumetric increase of 900 percent when tested in accordance with ASTM E946, Test Method for Water Absorption by Porous Plate Method, and the ability for 2 grams of material, mechanically reduced to pass a U.S. No. 100 sieve, to swell in water to an apparent volume of 16 ml's when added slowly to 100 ml's of water.

C. The GCL shall be manufactured so that the bentonite shall be continuously contained throughout the GCL and to support the geotextiles so that no displacement of the bentonite occurs when the material is unrolled, moved, cut, torn, or punctured. Any adhesive used shall be inert, nontoxic, and water soluble. GCL materials made without the use of adhesives shall be stabilized to contain the granular bentonite by a process such as needle-punching through the top and bottom layers of geotextile and the bentonite.

D. The encapsulating geotextile materials shall protect the bentonite and be sufficiently porous to allow bentonite flow-through to create a positive bentonite-to-bentonite seal at the seams.

E. Prior to packaging the finished product, the manufacturer shall inspect each roll over the entire surface area by using a strong light source on one side of the panel and observing the other side for zones of inadequate bentonite distribution or by using other reliable methods to detect deficiencies in the uniformity of the bentonite distribution. Deficient rolls shall be rejected.

F. Each roll shall be labeled with the length, width, and weight, along with the lot number and date of manufacture.

G. The GCL shall be CLAYMAX(R) as manufactured by Clem Environmental Corp., Chicago, IL; or BENTOMAT(R) as manufactured by Colloid Environmental Technologies Co. (CETCO), Arlington Heights, IL; or Bentofix as manufactured by Albarrie Naue Ltd., Barrie, Ontario, Canada; and shall meet the following requirements:

Property	Requirement	Test Method
Mass (Weight), lb/sq yd, MinARV	9.5	ASTM D3776
Thickness, in., plus or minus 0.03 in., MinARV	0.25	ASTM D1777
Bentonite Content, lb/sq ft at 12% moisture content, MinARV	0.9	ASTM D3776
Wide Width Tensile Strength, lb/in.-width, Tested Dry, MinARV	40	ASTM D4595
Puncture Strength, lb, Tested Dry, MinARV	60	ASTM D4833
Grab Strength, lb/in.-width, Tested Dry, MinARV	90	ASTM D4632
Grab Elongation, %, Tested Dry, MaxARV	15	ASTM D4632
Angle of Friction, Degrees Apparent Cohesion, lb/sq ft, MinARV Slip-Plane Interface Strength Within Hydrated Bentonite Layer	12 500	ASTM D3080, Modified
Permeability with Water under 400 lb/sq ft Normal Load, cm/sec, MaxARV	$1x10^{-9}$	ASTM D5084
Finished GCL Roll Width, Feet, MinARV	12	Linear Measurement
Finished GCL Roll Length, Feet, MinARV	100	Linear Measurement

2.2 BENTONITE SEALING COMPOUND

A. Bentonite sealing compound in powder or granular form shall be the same product used in the manufacture of the GCL materials.

B. The sealing compounds shall be applied to seal around all penetrations and structures shown on the Drawings and under repair patches. The manufacturer shall recommend the minimum amount of sealing compound to use in each instance in order to effect an adequate seal.

C. The sealing compound shall be furnished by the manufacturer of the GCL product furnished for this project.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

A. Inspect GCL materials delivered to the project site for damage. Inventory by quantity, lot number, panel size, and weight. Provide copy of inventory to RESIDENT ENGINEER.

B. Store GCL in a dry, protected facility or in a protected area on pallets off the ground and covered with a heavy, waterproof membrane that allows the free flow of air between the membrane and the materials.

C. Each day remove from storage only the rolls of material that are to be installed on that particular day. Stored GCL materials shall be kept under protective cover at all times. Protect the integrity of the GCL materials at all times during the course of the project. Replace materials that are damaged or contaminated with dust, dirt, or excess moisture at the CONTRACTOR's sole expense.

D. The GCL is to be completely covered and protected at the end of each shift or workday. The CONTRACTOR shall be fully responsible to protect the GCL from damage, shrinkage, or prehydration and shall replace all affected materials at the CONTRACTOR's sole expense.

E. To prevent premature hydration or shrinkage in hot weather, only the amount of GCL that can be anchored, inspected, repaired, and covered in the same day shall be installed. Maintain GCL in dry condition until covered with concrete.

F. Any leading edge or panels of GCL left uncovered shall be protected with a heavy, waterproof membrane or tarp which is adequately secured and protected with sandbags or other ballast.

G. Equipment used to installed the cover materials shall not operate directly on the GCL.

3.2 SURFACE PREPARATION

A. The surface on which the GCL is to be installed shall be prepared by removing all material that may interfere with the Work. Pull back GCL placed for Schedule D and place in stockpiles for reuse. Repair any holes or other irregularities in cement-bentonite wall or other surfaces to receive GCL. Surfaces shall be smooth and free of irregularities that may damage GCL.

B. The surface on which the GCL is to be placed shall be maintained in a firm, clean, dry, and smooth condition during GCL installation.

3.3 PLACEMENT OF GEOSYNTHETIC CLAY LINING

A. Place the GCL on the underlying cement bentonite material with the surface of the GCL in contact with the cement bentonite. Place all subsequent panels in the same manner.

B. The GCL panels shall not be dragged over the surface, except for slight adjustments as may be necessary for obtaining the correct overlap of panels. The rolled-up panels shall not be allowed to unroll unrestrained down any slope.

C. The panels shall be placed to provide an overlap of 6 to 9 inches on longitudinal seams and 24 inches on transverse seams.

D. The GCL panels shall not be installed while it is raining or when rain may begin before the panels can be covered with temporary plastic cover and protected. The GCL shall be "dry" when installed and covered with concrete.

E. The GCL shall be free of tension or stress upon completion of the installation. The GCL shall be laid smooth without creases or wrinkles and without stretching the material to fit an area.

3.4 SEAMING GCL PANELS

A. Overlap marks 6 and 9 inches from the panel edge shall be marked longitudinally on the GCL to assist in obtaining the proper overlap.

B. Prior to lapping, remove all dirt, gravel, or other debris from the overlap area. Apply 1/4 pound of sealing compound per lineal foot of seam.

C. The installer shall provide compensation for shrinkage when ambient temperatures are greater than 85 degrees F and the humidity is low, as shrinkage may occur soon after placement when no confining concrete over the GCL is placed. To compensate, as a minimum, the longitudinal overlap should be increased to 12 inches and the transverse overlap should be increased to 36 inches. Severe conditions with temperatures much greater than 85 degrees F may require an even greater overlap to be determined by the CONTRACTOR and accepted by the RESIDENT ENGINEER.

3.5 PATCHING AND REPAIRS

A. Irregular shapes, cuts, or tears in installed GCL shall be overlapped with an additional layer of GCL material a minimum of 12 inches in all directions from the defect on all patches. Patch seams parallel to the slope shall be secured with nontoxic, water soluble adhesive as accepted by the manufacturer and the RESIDENT ENGINEER. Complete panels shall be removed and replaced with undamaged panels when damage is extensive as determined by the superintendent and the RESIDENT ENGINEER.

3.6 REPLACEMENT OF BEDDING GRAVEL, GCL, AND ARMOR LAYER

A. After concrete is placed over GCL and forms are removed, CONTRACTOR shall place granular backfill against concrete up to elevation of 4-inch layer of bedding gravel. Replace GCL previously removed. Repair if damaged or hydrated. Place GCL against concrete and bend upward as shown. Replace 6-inch layer of protective gravel and armor stone. Obtain RESIDENT ENGINEER's approval or completed Work.

END OF SECTION

SECTION 02271
RIPRAP AND RIPRAP BEDDING

PART 1 GENERAL

1.1 DEFINITIONS

A. Refer to applicable definitions in Section 02220, FILL AND BACKFILL.

1.2 SUBMITTALS

A. Shop Drawings:

1. Description and location of proposed sources of riprap bedding and riprap.
2. Description and location of three projects where proposed riprap has been successfully used for minimum 5 years' duration under similar service conditions.

B. Samples:

1. General:
   a. Deliver to site at a location designated by RESIDENT ENGINEER.
   b. Incorporate Samples into Work after material placement is nearly complete.
2. Riprap: Provide minimum:
   a. 20 tons.
   b. Each Sample shall meet gradation requirements specified, include at least one piece of maximum size, and be representative of material to be furnished for incorporation into Work.

C. Quality Control Submittals:

1. Certified Test Results:
   a. Gradation for riprap bedding.
   b. Abrasion resistance for bedding and riprap.
   c. Bulk density for riprap.

1.3 QUALITY ASSURANCE

A. Riprap Source: Quarry that has produced riprap and has performed satisfactorily on other projects for at least 5 years.

1.4 SCHEDULING AND SEQUENCING

A. Complete subgrade preparation as specified in Section 02215, SUBGRADE PREPARATION, prior to placing riprap.

PART 2 PRODUCTS

2.1 RIPRAP BEDDING

A. Gravel with Cobbles:

1. Gradation, as determined in accordance with ASTM C136-84a:
   a. Well-graded from coarse to fine.
   b. All pieces pass a 12-inch square opening.
   c. 85 to 100 percent by weight passes 10-inch square opening.
   d. 20 to 60 percent by weight passes 3-inch square opening.
   e. 0 to 10 percent by weight passes 1-inch square opening.
2. Abrasion Resistance: Maximum 35 percent wear when tested in accordance with ASTM C535-89.

B. Free of roots and other organic or deleterious matter.

C. Onsite material from excavations or designated borrow sources that meets or is processed to meet requirements specified above may be used as riprap bedding in lieu of importing material.

2.2 RIPRAP

A. Hard angular and durable quarry stone free from fractures, bedding planes, pronounced weathering, and earth or other adherent coatings.

B. Minimum Dimension of Individual Pieces: Not less than 1/3 maximum dimension.

C. Abrasion Resistance: Maximum 35 percent wear as determined in accordance with ASTM C535-89.

D. Soundness: Maximum 10 percent loss as determined in accordance with ASTM D5240 or crushed and tested in accordance with ASTM C88.

E. Bulk Density: Minimum 160 pounds per dry cubic foot.

F. Gradation:

1. Well graded from coarse to fine.
2. 100 percent by weight smaller than 4,000 pounds.
3. 50 percent by weight smaller than 2,000 pounds.
4. 5 percent by weight smaller than 1,000 pounds.
5. Smaller pieces shall generally fill voids between larger pieces without either an excess or a deficiency of one or more sizes of stone.

PART 3 EXECUTION

3.1 PLACING RIPRAP BEDDING

A. Make three passes over excavated subgrade with vibratory roller weighing at least 15,000 pounds. Place riprap bedding and spread with dozer.

B. Compact with three passes of 15,000-pound vibratory roller. Work riprap bedding as necessary to distribute it and to eliminate detrimental voids. Avoid overworking or long pushes that result in segregation of particle sizes.

C. Grade surface of riprap bedding free from irregularities and to tolerances of 0.2 foot from established grade.

D. Place and grade riprap bedding in a manner that avoids subgrade disturbance.

3.2 PLACING RIPRAP

A. Place riprap over riprap bedding to minimum thickness taking care not to displace or penetrate bedding.

B. Intermix different sizes of pieces to eliminate segregation and to fill voids between larger pieces with smaller pieces and work surface free from irregularities.

C. Use placement and intermixing methods that avoid disturbing riprap bedding or damaging existing facilities, completed Work, or adjacent property.

D. Make three passes over complete riprap surface with D8 dozer or larger. Smooth irregularities until approved by RESIDENT ENGINEER.

END OF SECTION

SECTION 02272
GABION MATTRESS CONSTRUCTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work necessary for the removal and replacement of gabion mattress and buttress construction, complete.

PART 2 PRODUCTS

2.1 GABIONS

A. New heavy-duty wire mesh galvanized gabions as manufactured by Maccaferri Gabions, Inc., New York, NY, or equivalent. Sizes shall be as shown on the Drawings.

B. Reuse of removed gabions will not be allowed.

2.2 BINDING WIRE

A. U.S. 13-1/2-gauge galvanized wire or as recommended by the manufacturer.

2.3 GABION FILL MATERIAL

A. Clean, hard cobbles or crushed rock; 12-inch maximum particle size, 4-inch minimum particle size. Average stone size is 6 inches.

2.4 EARTH BACKFILL

A. Material from the excavations free from roots, debris, organic material, or other deleterious materials as specified in Section 02200, FILL AND BACKFILL.

2.5 UNCLASSIFIED EXCAVATION

A. All excavation is unclassified. Complete all excavation, regardless of the type, nature, or condition of the materials encountered. CONTRACTOR shall make own estimate of the kind and extent of the various materials to be excavated in order to accomplish the work.

2.6 GEOTEXTILE

A. Nonwoven, pervious sheet as shown to match existing product. Fibers of the fabric shall be constructed into a stable network that retain their relative position with respect to each other.

PART 3 EXECUTION

3.1 STRUCTURAL EXCAVATION

A. Perform all excavation, regardless of the type, nature, or condition of the material encountered. The method of excavation used is optional; however, no equipment shall be operated within 5 feet of existing structures or newly completed construction.

B. Excavation that cannot be accomplished without endangering existing or new structures shall be done with hand tools.

3.2 LIMITS OF EXCAVATION

A. Excavate to the depths and widths required to accomplish the construction. Cuts belowgrade shall be corrected by replacing with compacted earth backfill, compacted to a minimum of 90 percent relative compaction at a moisture content within 2 percent of optimum. CONTRACTOR shall bear all costs for correcting overexcavated areas.

3.3 GABION REMOVAL

A. Protect existing gabions from damage from equipment and materials at all times during removal and installation.

B. Remove existing gabion mattresses and buttresses where required to complete the elements of Work.

C. Remove top of gabion mattress by cutting tie wire at side or end of basket or by securing remaining top to internal divider or diaphragm and cutting away top to be removed. Secure top to dividers or diaphragms with tie wire in accordance with manufacturer's requirements.

D. Remove stone fill from mattresses and buttresses in a manner that will not damage the adjacent gabions or structures. Stone fill should be protected from contamination with other material so it can be reused in the replaced gabions.

E. Remove the remaining gabion mattress and basket at an end or side or secure and remove at a divider or diaphragm in accordance with manufacturer's requirement.

F. Cut and remove geotextile beneath gabions leaving 1.5 feet of material for overlap during gabion replacement.

3.4 GABION ASSEMBLY

A. Place the first layer of gabion to the line and grades shown on the Drawings. Gabion edges shall be continuously wired together, using binding wire specified hereinbefore. Adjoining gabions shall be wired together along their vertical edges. Empty gabions shall be stretched and held in place while filling as recommended by the manufacturer. Empty

gabions stacked on filled gabions shall be wired to the filled gabions at the front and back.

3.5 GABION CONSTRUCTION

A. Place gabion fill in layers not thicker than 1 foot. Along all exposed gabion faces, place the outer layer of stone by hand in order to provide a neat, compact, square surface. In addition to the gabion fill, within 1 foot from the exposed face, the rock interstitial voids shall be filled with topsoil to permit establishing a vegetative cover. After each 1-foot lift is completed, one binding wire connecting tie shall be placed in each direction, across the fill surface, connecting opposite faces. The connecting wire shall be looped at least twice around two nonadjacent meshes of the gabion wall, then the free end wrapped back around the standing end of the wire to form a snug connection. At no time allow any gabion to be filled to a depth of more than 1 foot above the adjoining gabions. After the gabion is filled to the top and leveled off, fold the lid shut and wire it to the ends, sides, and diaphragms using binding wire.

3.6 GEOTEXTILE

A. Surface Preparation: Remove or compact all materials on surface to receive geotextile. Roll surface with smooth roller to remove all undulations exceeding 1 inch. Obtain RESIDENT ENGINEER's approval of prepared surface.

B. Laying Geotextile: Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

C. Sheet Orientation on Slopes: Orient geotextile with long dimension of each sheet parallel to direction of slope (up and down slope) extending across the top of the embankment below the aggregate base course.

D. Joints: Overlap a minimum of 1.5 feet, unless otherwise shown.

E. Securing Geotextile: Secure geotextile during installation as necessary with sand bags, or other means approved by RESIDENT ENGINEER.

F. Placing Products Over Geotextile:

1. Before placing material over geotextile, notify RESIDENT ENGINEER. Do not cover installed geotextile until after RESIDENT ENGINEER provides authorization to proceed.
2. 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 specified in Article REPAIRING GEOTEXTILE.

G. Repairing Geotextile: Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile. Repair damaged geotextile by placing patch of undamaged geotextile over damaged area and 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 specified above in Article SECURING GEOTEXTILE, or by other means approved by RESIDENT ENGINEER.

3.7 SHORING, SHEETING, AND BRACING

A. Furnish and install all shoring, sheeting, and bracing required to support adjacent earth banks and structures, and for the protection and safety of all personnel working in the excavations. All shoring, sheeting, and bracing shall conform to the requirements of the state or local agencies having jurisdiction over such matters.

B. Remove shoring, sheeting, and bracing in a manner that will protect or prevent caving of banks or damage to property as the excavations are backfilled.

3.8 EARTH BACKFILL

A. Remove all form materials and trash from the excavation prior to placing any backfill. Place earth backfill in all areas not designated on Drawings to be backfilled with other materials. Deposit material in horizontal layers and compact each lift to a minimum of 90 percent of relative compaction. Backfill to the specified grade.

3.9 TOLERANCE

A. The following tolerances shall be maintained for the gabion wall construction:

1. Horizontal alignment plus or minus 4 inches, not to exceed 2 inches in any 5-foot length.
2. Slope face tilt not to deviate by more than 1 inch per foot when measured at the top and bottom gabion edges.

END OF SECTION

SECTION 02330
DRILLING AND GROUTING

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section specifies drilling grout holes through the CSA grade control structurez, furnishing all materials and equipment, and doing all work necessary for grouting, complete.

1.2 GENERAL

A. CONTRACTOR's work under this section shall include: All Work necessary to perform grout hole drilling and redrilling at the existing grade control structure located at the downstream dam; washing and water pressure testing of grout holes; furnishing, handling, transporting, and storing of all materials and equipment for grouting; mixing and injecting grouts; capping, patching, and plugging the finished grout holes; cleanup of work areas; and all other operations incidental to grouting.

B. The amount of drilling and grouting to be performed will depend upon the nature of the voids encountered as the Work proceeds, and on the method of construction. Drilling and grouting shall be performed at such locations, at such times, and in such quantities as shown or as necessary to conform to the requirements of this section.

1.3 DEFINITIONS

A. Compaction Grouting: Compaction grouting is defined as the injection of silty sand-cement grout to compact and displace soils beneath the base of the existing CSA grade control structure.

B. Contact Grouting: Contact grouting is the injection of cement grout into the body of the existing grade control structure to fill cracks and voids.

C. Refusal: Refusal is the point at which grouting is stopped on a grout hole. For compaction grout, it is defined as a grout injection rate of less than 1 cubic foot of grout over a 15-minute interval, at 100 percent of the required pressure. For contact grout, refusal is defined as a grout injection rate of less than 1/2 cubic foot of grout over a 15-minute interval, at 100 percent of the required pressure. These time intervals may be reduced at the option of the DESIGN ENGINEER based on progress of the grouting.

D. Connections: A connection consists of attaching the grout hose to the grout pipe, for permeability testing, or for injecting grout to refusal, or for regrouting as directed by DESIGN ENGINEER.

E. CSA: Cement stabilized alluvium placed for the existing grade control structure or shoreline erosion protection.

1.4 SUBMITTALS

A. Sequence of Work:

1. CONTRACTOR shall remove upper lifts of existing Cement Stabilized Alluvium (CSA) down to Elevation 1126.0 first in accordance with Section 02050, DEMOLITION. Drilling holes for anchors and installing anchors shall occur next in accordance with Section 02164, CSA GRADE CONTROL ANCHORS. Anchor bar grout shall be allowed to cure for 7 days prior to starting any grouting of existing grade control structure or foundation beneath it.
2. The locations of the grout holes shall be identified and marked by CONTRACTOR using an identification system. Grout holes shall be marked as primary and secondary in each row along the length of the dam. Alternating holes in both rows shall be deemed to be a primary grout hole with the holes between the primary holes identified as secondary holes. All primary holes shall be completely grouted before starting the secondary holes. All grouting shall be completed prior to excavation for roller compacted concrete. All contact grouting shall be completed prior to starting compaction grouting.

B. Experience Requirements: CONTRACTOR performing drilling and grouting shall provide verifiable evidence of performing grouting on at least two projects with a total value exceeding $200,000. Each project shall have a value of at least $75,000. The superintendent in charge of the onsite work shall be present at all times Work is being performed. The superintendent shall have at least 5 years of verifiable experience performing compaction and contact grouting on at least three different projects for each type of grouting required. CONTRACTOR shall submit qualifications of grouting contractor and superintendent to DESIGN ENGINEER at least 30 days prior to starting any Work on Project involving drilling of holes.

C. CONTRACTOR shall submit working drawings and descriptions of proposed grouting facilities including, but not limited to, equipment; methods; means of accurately measuring grout pressures and rate of grout injection; certification of calibrated pressure gauges; and proposed grout mixes. The submittal shall be made 30 days prior to commencement of grouting operations. CONTRACTOR shall resubmit as appropriate if the system is modified during the course of the work.

PART 2 PRODUCTS

2.1 GROUT, PORTLAND CEMENT

A. Portland cement and water used in grout mixes shall conform to the applicable requirements for such materials set forth in Section 03300, CAST-IN-PLACE CONCRETE. Cement for grout shall have a surface (fineness) of 350 square m/kg, as determined by ASTM C204; and shall have a minimum of 95 percent passing the No. 325 sieve, as determined by ASTM C430. Bentonite or fly ash may be added to the compaction grout mix when approved by DESIGN ENGINEER to increase pumpability. Bentonite shall be a high swelling montmorillonite product capable of

mixing with water to form a stable and homogeneous suspension. Bentonite shall conform to the requirements of API Spec. 13A. Fly ash shall conform to the requirements of ASTM C618, Class F. The addition of bentonite or fly ash shall not decrease the strength of the grout by more than 10 percent.

B. Cement grout for contact grouting shall consist of a mixture of water and portland cement, with fillers or admixtures as necessary to achieve a nonshrink, nonbleed grout. The grout shall have a minimum 28-day compressive strength of 4,000 psi.

C. The compaction grout mixture for filling voids at the base of the existing grade control structure shall consist of silty sand, with not less than 3 cubic feet of cement per cubic yard of grout, and water as necessary to achieve a pumpable mix with not more than a 6-inch slump. Compressive strength at 28 days shall not be less than 50 psi. The silty sand shall have a percent passing the No. 200 sieve of not less than 20 percent and not more than 30 percent. DESIGN ENGINEER may modify the mix materials to achieve greater penetration into voids.

D. Fluidifier may be added as approved or required by DESIGN ENGINEER.

E. Accelerator may be added as approved or required by DESIGN ENGINEER.

2.2 SAND

A. Sand for grout mixes shall be clean natural silica sand, graded such that all of the material passes the No. 20 sieve.

2.3 FLUIDIFIER

A. Fluidifier shall be a compound possessing such characteristics that it will tend to hold the solid constituents of the grout in suspension, and shall be compatible with the cement and water used in the grout mix. Fluidifier shall not contaminate the groundwater. Acceptable fluidifiers are calcium ligno-sulfonate and sodium ligno-sulfonate. The fluidifier shall contain a shrinkage compensator.

B. Fluidifier shall be furnished in moisture-resistant paper sacks shipped in sealed containers and shall be handled and stored so as to avoid absorption of moisture, damage, or waste. Material which has become caked due to moisture absorption will be rejected.

2.4 EQUIPMENT, DRILLING

A. Rotary core drilling equipment shall be used for drilling grout holes to the bottom of the CSA. Compaction grout holes shall be drilled with either a down hole percussion hammer or tricone rotary bit. The equipment shall be capable of drilling 3-inch diameter holes to depths of 30 feet. Larger holes may be drilled at the option of CONTRACTOR. The DESIGN ENGINEER will log all grout holes and log the CSA core and cuttings.

CONTRACTOR shall provide core boxes and haul cores to onsite storage location approved by DESIGN ENGINEER.

2.5 EQUIPMENT, CONTACT GROUTING WITHIN GRADE CONTROL STRUCTURE

A. Mixers shall be colloidal type capable of providing a homogenized mix and shall be capable of an impeller speed of not less than 1,500 rpm, such as "Colgrouter" manufactured by Acker Drill Company, Scranton, Pennsylvania; or equal. The grout mixer shall pump the grout into a mechanically agitated holding tank. Mixer and mechanical agitator tanks shall be of sufficient capacity to ensure an uninterrupted supply of grout to the grout pump. Means of accurately measuring the separate grout ingredients at the mixer shall be provided. Means shall be provided for increasing or decreasing the water-cement ratio, as required by the conditions in the CSA, without wasting of mixed materials.

B. Pumping equipment shall deliver grout from the holding tank to the point of injection at controlled pressures. Grout pumps shall be capable of delivering grout to the point of injection at a pressure of 100 psi at the top of the hole. Pumping equipment shall be capable of handling water-cement ratios as low as 0.5:1 by weight. A standby pump and mixer shall be available during grouting operations and shall be arranged in such a manner as to allow switchover without stopping the grouting operation.

C. Means shall be provided for accurately determining the amount of grout injected. This shall consist of a flowmeter compatible with grout slurries. The flowmeter shall be accurate within 10 percent at a flow rate of 2.5 gpm.

D. The grout plant shall be equipped with reliable pressure gauges at point of injection and at the pump. The pressure gauges shall have a range such that the maximum pressure specified shall be approximately 2/3 of the capacity of the gauge. The gauges shall be protected from grout contamination by an oil or air buffer, and shall be easily cleaned in the field.

E. Flexible hose for pressure grouting shall be capable of withstanding the maximum water and grout pressures to be used. A valve shall be provided on each grout hose and a straightway valve at each grout pipe to regulate flow. Packers for grouting shall be pneumatic, hydraulic, or mechanical expandable rubber packers.

F. At the point of injection, suitable valves and pressure gauges shall be provided so that the pressure may be monitored and the grout flow regulated by increasing or decreasing the flow in the grout return line. Suitable stop valves shall be provided at the collar of the hole for use in maintaining pressure as required until the grout has set.

G. Grouting equipment shall be of such configuration that flushing can be accomplished with the grout injection valve closed, with the water supply valve open, and with the grout pump running at full speed.

H. If out of visible contact, continuous telephonic communication shall be maintained between the grout plant and injection point.

2.6 EQUIPMENT, COMPACTION GROUTING BENEATH GRADE CONTROL STRUCTURE

A. The mixer shall be of the pug mixer type, and shall ensure complete and uniform mixing of the materials used and be of sufficient capacity to continuously provide the pumping unit with mixed grout at its normal pumping rate. The pumping unit shall be capable of continuously delivering the specified grout materials at a pump pressure sufficient to produce the specified pressure at the top of the injection hole. Pressure gauges shall be supplied at the pump and at the point of injection. Grout pipes shall be at least 1.5 inches in diameter.

B. Continuous telephonic communication shall be maintained between the grout plant and the injection point.

2.7 QUALITY ASSURANCE

A. CONTRACTOR shall furnish one set of calibrated pressure gauges to be used as a master to check pressure gauges in the field. Proper certifications attesting the same shall be provided to DESIGN ENGINEER. Proper fittings shall be provided for connection of calibrated pressure gauges parallel to field gauges, for periodic checking of field gauges. CONTRACTOR shall also furnish suitable devices for determining the accuracy of all volumetric and flow rate measuring devices, as required.

PART 3 EXECUTION

3.1 GENERAL

A. All drilling, hole washing, and grout injection operations shall be carried out with DESIGN ENGINEER's approval and in the presence of DESIGN ENGINEER. Notify DESIGN ENGINEER at least 24 hours in advance of the start of grouting operations.

B. All grout shall be maintained at temperatures above 50 degrees F until injected. The temperatures of mixing water shall range from 50 degrees F to 100 degrees F when added to the grout mixer.

C. Drilling of contact grout holes to the base of the existing grade control structure shall be by rotary coring methods, as specified. The circulating fluid shall be clean and free of drill cuttings when introduced into the drill hole, and shall not plug or contaminate the grout injection zone. Based on the drilling information for the CSA grade control anchors and other previous borings, DESIGN ENGINEER will determine the drilling depth for each grout hole.

D. Grout holes shall be protected from becoming clogged or obstructed prior to grouting by means of a cap or other suitable device on the collar of the hole. Any hole that becomes blocked or otherwise unsuitable for its

intended purpose shall be cleaned out in a manner satisfactory to DESIGN ENGINEER or replaced.

E. All grout hole locations shall be flagged and protected. They shall be clearly labeled for easy identification and shall be clearly visible.

3.2 INJECTION PROCEDURES FOR CONTACT GROUTING

A. CONTRACTOR shall embed grout pipes in the upper 2 feet of the CSA grade control structure for contact grouting using expandable packers or other suitable means to secure the pumping hose connections. Grout pipes shall be thoroughly cleaned before embedment. Grout pipes shall be set so that grout can flow freely to the voids and crevices.

B. Grout materials shall be mixed in mixer for a minimum of 3 minutes and maximum of 2 hours. Grout in mixer and holding tanks shall be continuously agitated. The pressure or rate of pumping shall not be increased suddenly. Equipment and lines shall be kept clean by constant circulation of grout and periodic flushing with water. Leakage from connections will not be permitted. Plugs on ends of nearby grout holes that or pipes shall be removed to permit escape of air and water and the filling of spaces with grout.

C. Once started, grouting of a hole shall not be interrupted without specific approval of DESIGN ENGINEER. Grouting of a hole shall not be considered complete until that hole refuses to take grout as defined under Paragraph REFUSAL. After grouting of a hole or any stage of a hole that has reached refusal, the pressure on the hole shall be maintained by means of a stopcock or other suitable device until the grout has set.

D. Grout progressively from hole-to-hole in the sequence required or approved. Grout all primary holes first and then secondary holes. If necessary to relieve premature stoppage, periodic applications of water under pressure shall be made. Grout that cannot be placed prior to initial set shall be wasted. Check operating gauges daily to determine that they are in working order. Do not grout without appropriate gauges in place and in working order.

E. Additional grout headers, to a maximum of 5, shall be available to connect to interconnecting holes. Permission by DESIGN ENGINEER to grout more than one hole at a time will be contingent upon CONTRACTOR's ability to maintain directed grout flow and pressure to the interconnecting holes.

3.3 INJECTION PROCEDURES FOR COMPACTION GROUTING

A. CONTRACTOR shall redrill holes following contact grouting.

B. The grout holes shall be extended to a depth of 10 feet below the bottom of the existing CSA where soil is present and 5 feet below CSA if bedrock is present. Case holes if caving occurs. Perform compaction grouting within 7 days of drilling holes or redrill and reclean before grouting. Grouting will be performed by isolating the grout hole below the CSA grade control

structure using expandable packers placed in the CSA not more than 5 feet above the base of the CSA. Washing of the hole below the CSA will not be required for holes in soil.

C. A permeability test shall be conducted at all grout holes prior to compaction grouting. The test shall consist of measuring water inflow to the zone below the CSA under a maximum of three pressures designated by DESIGN ENGINEER, for a maximum duration of 5 minutes for each test pressure. Expandable packers shall be used at the base of the CSA to seal off the portion of the hole to be tested. CONTRACTOR shall provide all gauges and equipment necessary to calibrate and perform permeability testing. Open-hole testing may be required in addition to the pressure test if verification of tests is needed.

D. The initial grout mix and grout pressure shall be as directed by DESIGN ENGINEER, and will be determined on the basis of the results of the permeability tests. Thin mixes shall be used where the permeability is low and thick mixes where the permeability is high. Alteration of the grout mix, grout pressure, and pump speed throughout the grouting operation to achieve the desired results shall be as directed by DESIGN ENGINEER.

E. Compaction grout shall be injected through the grout pipes into the soil below the CSA at locations shown. If necessary to initiate the flow of grout at the start of pumping, the grout pipe shall be pulled a few inches with the grout pressure applied, or an initial cavity shall be produced by jetting or blowing. Pumping shall proceed continuously at a rate between 0.1 to 4.0 cubic feet per minute. If agitated continuously, the grout may be held in the grout plant for not more than 2 hours.

F. For compaction grouting, the grouting pressure at the packer located at the base of the grade control structure shall be not more than 1.5 psi per foot of depth of existing CSA plus 1.0 psi per foot of depth of soil overburden, unless otherwise approved by DESIGN ENGINEER. Pressure shall be computed with reference to the top of the grout zone at the base of the grade control structure. A maximum pressure of 150 psi will be required.

G. If it is found impossible to reach the required pressure after pumping a reasonable volume of grout at the minimum workable water-cement ratio, DESIGN ENGINEER may require the speed of pumping to be reduced or pumping to be stopped temporarily. This intermittent grouting shall be performed to allow sufficient time between grout injections for the grout to stiffen. Additionally, DESIGN ENGINEER may allow the introduction of additional cement and sand to the grout. Following these procedures, if the desired result is not obtained, grouting the hole shall be discontinued, the hole shall be cleaned, and the grout below the CSA allowed to set. Additional drilling and grouting shall then be done in this hole or an adjacent area until the desired result is obtained.

H. Upon completion of compaction grouting, grout pipes shall be removed and the grout holes filled to the top of the CSA with a cement/water/sand mix having a compressive strength of at least 1,000 psi.

3.4 QUALITY ASSURANCE

A. Calibration of all pressure gauges and meters shall be performed at least once per week, or as directed by DESIGN ENGINEER. Records of the calibrations shall be provided to DESIGN ENGINEER within 1 working day of the calibrations.

3.5 RECORD KEEPING

A. Accurate records of all drilling and grouting operations shall be kept by CONTRACTOR and furnished to DESIGN ENGINEER within 1 working day of performance of the work. Records shall include as a minimum: Hole location and depth; log of holes drilled; results of washing and water pressure testing operations; time of each change of grouting operations; grout volume and pressure at each hole; grout mix; pumping times; amount of grout pumped for each change in mix ratio; date and time of performance of the work; and any other data required by DESIGN ENGINEER. Records kept by DESIGN ENGINEER shall not relieve CONTRACTOR of this requirement.

B. CONTRACTOR shall measure all quantities for payment. DESIGN ENGINEER will review CONTRACTOR's measurement and determine the appropriate quantities. CONTRACTOR shall cooperate with DESIGN ENGINEER in making measurements.

3.6 CLEANUP

A. During grouting work, provide for proper disposal of all waste materials, grout, and water.

END OF SECTION

SECTION 02401
CEMENT-BENTONITE BACKFILL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work necessary for construction of the backfill adjacent to the cement-bentonite cutoff wall, complete.

1.2 DEFINITIONS

A. Cement-Bentonite Cutoff Wall: A continuous low-strength, low-permeability water barrier formed by backfilling a slurry trench with the specified cement-bentonite mixture. This structure will be constructed under Schedule D and be completed prior to required access for Schedule B contractor.

B. Groundwater Level: The piezometric level of the groundwater as determined from piezometers installed in the alluvium in the vicinity of the slurry wall.

C. Well-Graded: Well-graded as used in this section defines a mixture of particle sizes that have no specific concentration or deficiency of one or more sizes. Well-graded is used to help define a material that, when placed in the slurry trench, produces a relatively impermeable material free from detrimental voids.

D. API: American Petroleum Institute.

E. API RP: API Recommended Practice.

F. Unclassified Excavation: Removal of all material encountered regardless of the geologic formation, degree of induration, hardness, or other property.

G. Fines: Material passing the U.S. Standard No. 200 sieve, when tested in accordance with ASTM C117.

H. GCL: Geosynthetic clay liner. As specified in Section 02247, GEOSYNTHETIC CLAY LINING (GCL).

1.3 SUBMITTALS

A. Certification, test results, and samples for all imported material, including bentonite.

B. Catalog and manufacturer's data sheets for cement-bentonite, slurry mixing, and placing equipment.

C. Plan for mixing and placing cement-bentonite backfill.

D. Test results for design mix of cement-bentonite backfill including permeability, slump, moisture content and grain size distribution.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide all labor, materials, and equipment necessary to accomplish the work specified in this section.

2.2 BACKFILL

A. The cement-bentonite backfill mix shall be designed by CONTRACTOR. The mixed backfill shall meet the following requirements:

1. Hydraulic conductivity shall not exceed 1.0 (10^{-6}) cm/sec when tested in accordance with ASTM D5084. Compressive strength between 10 and 50 psi at 28 days.
2. Backfill shall be a mix of the following materials, as specified in this section, in the proportions determined by CONTRACTOR's mix design:
   a. Select backfill soil.
   b. Imported fine-grained soil.
   c. Bentonite.
   d. Slurry.
   e. Cement.
3. Submit a mix design report prepared under the supervision of and sealed by a professional engineer licensed in the State of Arizona, with at least 5 years of experience in slurry wall design and construction. The mix design report shall show the results of various tests at varying proportions of the above materials, and varying bentonite contents, so as to identify an appropriate mix to achieve the hydraulic conductivity specified. Initial and intermediate hydraulic conductivity testing may be conducted in fixed-wall permeameters. Final testing to verify the mix hydraulic conductivity for the proposed mix design shall be accomplished in strict accordance with ASTM D5084.
4. DESIGN ENGINEER reserves the right to increase the amount of bentonite and cement to be added to the mixed backfill up to 3 percentage points over the amount recommended in the mix design report.

2.3 BENTONITE

A. Pulverized or powdered premium grade natural sodium cation bentonite, conforming to the requirements of the standards of API Specification 13A, with a minimum yield of 90 barrels per ton when tested in accordance with API RP 13B. Protect bentonite from moisture and contamination in transit and in storage at the site.

2.4 CEMENT

A. General: Cement shall be furnished in bulk except that cement for finishing and patching may be packaged. The source of cement shall consistently supply material with similar chemical and physical properties. The sources of cement shall not be changed from those submitted at the time of bid without written approval by DESIGN ENGINEER.

B. Portland Cement: Portland cement shall be Type II cement and shall meet the requirements of ASTM C150, including Table 1 and Table 2.

C. Cement Sources: Each shipment of cement shall be accompanied by a certified delivery slip or mill certificate of compliance showing results of physical and chemical tests along with Specification requirements. No cement shall be used until written notice has been given by the DESIGN ENGINEER that test results are satisfactory. In the event of failure, the cement may be resampled and tested at the request of the CONTRACTOR and at the CONTRACTOR's expense.

2.5 ADMIXTURES

A. The use of any admixture, or of any plugging or bridging agent, will not be permitted without prior written authorization from DESIGN ENGINEER.

2.6 SELECT BACKFILL

A. This material is not available onsite and must be either manufactured by processing onsite material, or imported.

B. Excavated and processed or imported material, free from roots, organic matter, trash, debris, rocks larger than 3 inches, and other deleterious materials. Select backfill shall conform to the following washed sieve gradation when tested in accordance with ASTM C117 and C136:

Sieve Size	Percent Passing by Weight
3 inch	100
1 inch	80 - 100
1/2 inch	65 - 98
No. 4	50 - 90
No. 40	15 - 50
No. 200	5 - 30

C. To the extent possible, obtain from required excavation. If additional select backfill is required to accomplish the work, obtain from the borrow area shown or as designated, or import material of equivalent quality, at CONTRACTOR's option. No additional payment will be made if CONTRACTOR elects to import material.

2.7 EXCESS EXCAVATION

A. All excavated material that does not meet the requirements for SELECT BACKFILL.

2.8 IMPORTED FINE-GRAINED MATERIAL

A. Friable, nonindurated natural earth material with at least 50 percent passing the No. 200 sieve when tested in accordance with ASTM D1140 as modified herein. Determination of the percent passing the No. 200 sieve shall not use dispersing agents, the ASTM D1140 mixer, or other mechanical mixers, and the soil shall be broken down using only manual agitation. Furthermore, the soil shall be soaked no more than 12 hours before washing.

B. When tested in accordance with ASTM D4318, the Atterberg Limits of imported material shall conform to the following:

1. Liquid Limit: 25 to 55.
2. Plasticity Index: 10 to 30.

C. To the extent possible, obtain the imported fine-grained material at a low moisture content so that it behaves as a dry material. Protect imported fine-grained material from moisture and contamination both in transmit and in storage at the site.

2.9 WATER

A. Use only potable water to form the cement-bentonite backfill.

B. Potable water will be provided by OWNER, as specified in Section 01500, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS.

2.10 IMPORTED MATERIAL ACCEPTANCE

A. Other than bentonite, all imported materials specified in this section are subject to the following requirements:

1. All tests necessary for CONTRACTOR to locate an acceptable source of imported material shall be made by CONTRACTOR. Certification that the material conforms to the Specification requirements along with copies of the test results from a qualified commercial testing laboratory shall be submitted to DESIGN ENGINEER for approval at least 10 days before the material is required for use. All samples shall be furnished by CONTRACTOR at CONTRACTOR's sole expense. Samples shall be representative and be clearly marked to show the source of the material and the intended use on the project. Sampling of the source shall be done by CONTRACTOR in accordance with ASTM D75. Notify DESIGN ENGINEER at least 24 hours prior to sampling. DESIGN ENGINEER may, at DESIGN ENGINEER's option, observe the sampling procedures. Tentative acceptance of the source shall be based on an inspection of the source by DESIGN ENGINEER and/or the certified test results submitted by

CONTRACTOR to DESIGN ENGINEER, at DESIGN ENGINEER's discretion. No imported materials shall be delivered to the site until the proposed source and materials tests have been tentatively accepted in writing by DESIGN ENGINEER. Final acceptance will be based on tests made on samples of material taken from CONTRACTOR's on-site stockpile. All testing for final acceptance shall be performed by DESIGN ENGINEER.

2. Tests by CONTRACTOR shall be made on samples taken at the place of production prior to shipment. Tests shall be as specified for the material in question. Samples of the finished product for testing shall be taken from each 100 cubic yards of material or more often as determined by DESIGN ENGINEER, if variation in gradation is occurring, or if the material appears to depart from the Specifications. Test results shall be presented in writing to DESIGN ENGINEER within 48 hours after sampling.
3. If tests conducted by CONTRACTOR or DESIGN ENGINEER indicate that the material does not meet Specification requirements, material placement shall terminate until corrective measures are taken. Material that does not conform to the Specification requirements and that has been placed in the Work shall be removed and replaced at CONTRACTOR's sole expense. Sampling and testing performed by CONTRACTOR shall be done at CONTRACTOR's sole expense.

2.11 BENTONITE ACCEPTANCE

A. Submit to DESIGN ENGINEER certification from the manufacturer that the bentonite conforms with API Specification 13A and these Specifications prior to placing orders.

B. Submit samples of bentonite to DESIGN ENGINEER for tentative acceptance prior to placing orders. Samples shall be representative and clearly marked to show the source of the material and the intended use on the Project. Final acceptance of bentonite shall be based on tests made on samples of bentonite taken from CONTRACTOR's onsite bentonite storage facilities. All testing for final acceptance will be performed by DESIGN ENGINEER.

2.12 EQUIPMENT

A. All equipment shall be maintained and operated in strict accordance with the manufacturer's instructions and recommendations. All equipment shall be free of fluid leaks which discharge substances onto the ground or into the trench. Immediately repair or remove from the site all broken or leaky lines, hoses, valves, pistons, pipes, tanks, and other equipment components. Equipment shall be maintained in such condition that it will deliver the manufacturer's rated output. If inadequate quantity or quality of production is obtained, provide larger and/or different equipment.

B. Backfill Mixing and Placing Equipment: Equipment for mixing and placing backfill shall be a suitable type capable of producing a homogenous mixture of backfill materials meeting the Specifications. CONTRACTOR shall submit a mixing plan to DESIGN ENGINEER describing equipment and

methods for placing the backfill. CONTRACTOR shall obtain DESIGN ENGINEER's approval prior to starting excavation.

C. Moisture Control Equipment: Equipment for applying water shall be of a type and quality adequate for the Work, shall not leak, and shall be equipped with a distributor bar or other approved device to assure uniform application. Equipment for mixing and drying out material shall consist of blades, discs, or other approved equipment.

2.13 QUALITY CONTROL EQUIPMENT

A. CONTRACTOR's Equipment: Provide all equipment necessary for CONTRACTOR's quality control testing. Minimum quality control testing by CONTRACTOR is specified hereinafter. Provide any additional equipment necessary for any additional testing CONTRACTOR elects to do. All equipment shall be maintained in good working order, and shall meet the requirements of the applicable test standards cited herein.

PART 3 EXECUTION

3.1 EXCAVATION–GENERAL

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered. Make own estimate of the kind and extent of the various materials to be excavated in order to accomplish the Work.

B. The working surface for the excavation shall be located at the existing elevation of the top of the adjacent CSA grade control structure and top of cement-bentonite slurry wall, except where higher elevations are required for stability or construction access, and such higher grades are authorized in writing by DESIGN ENGINEER.

C. Excavate to expose the existing CSA adjacent to the cement-bentonite slurry wall. Excavate to explore the existing cement-bentonite cutoff wall without damaging previous Work. Remove portions of the slurry wall that are damaged in any way to a depth acceptable to the DESIGN ENGINEER.

D. Remove all CSA protrusions, partially compacted material, broken pieces, or other disturbed or loose CSA or soil material down to Elevation 1121.0.

E. Remove all loose or disturbed material from the sides and bottom of the excavation to the degree acceptable to the DESIGN ENGINEER. Use water jet to clean all CSA and slurry wall surfaces prior to placing backfill.

F. Construction surcharges including, but not limited to, excavated material, backfill mixing operations, excavating equipment, and pumping equipment, shall be kept away from the excavation. Only equipment required for excavation and backfilling shall be allowed adjacent to the excavation.

3.2 DISPOSAL OF EXCAVATED MATERIAL

A. Dispose of all excavated material in the disposal areas shown, or as directed by RESIDENT ENGINEER.

3.3 BACKFILL IN CASE OF HIGH WATER

A. In the event groundwater rises within the excavation or surface water is seeping into the excavation, DESIGN ENGINEER will require CONTRACTOR to stop excavation and to begin continuous operations to either dike around the open excavation to lower the groundwater in the vicinity of the trench by use of wells or well points.

3.4 BACKFILLING

A. General: Do not begin backfilling any portion of the excavation until such portion has been dewatered, cleaned, and accepted by DESIGN ENGINEER.

B. Mixing:

1. Mixing shall generally be accomplished in the following stages:
   a. Thoroughly mix dry bentonite and cement with imported fine-grained material.
   b. Thoroughly mix the backfill using a pugmill or batch plant.
2. The method of proportioning backfill components and mixing the backfill shall be determined by CONTRACTOR. The method used must meet the following criteria:
   a. The quantities and percentages of all backfill components shall be easily and accurately measurable by both CONTRACTOR and DESIGN ENGINEER.
   b. The imported fine-grained material shall be broken down such that it is thoroughly dispersed in the backfill.
   c. The moisture content of the backfill shall be increased only with the addition of bentonite slurry. The use of water is prohibited.
   d. All backfill components shall be thoroughly dispersed and the backfill shall be homogeneous and shall have the properties specified herein.
3. Submit to DESIGN ENGINEER at least 2 weeks prior to mixing and placing backfill, the backfill mixing plan. The plan shall contain as a minimum the general sequence of placement of backfill components, procedures to be used to verify that the proper proportions of each component are included, and the methods and equipment to be used to mix and place the backfill. DESIGN ENGINEER must approve the plan prior to beginning placement
4. The methods of mixing the backfill shall be demonstrated to DESIGN ENGINEER at least 1 week prior to mixing any backfill. The demonstration shall use the same methods, equipment, and personnel proposed for the excavation. The demonstration shall mix a minimum of 10 cubic yards of backfill. Backfill mixed for the demonstration may not be reused and placed in the excavation.
5. DESIGN ENGINEER will make the determination on the acceptability of the backfill mixing procedures. If DESIGN ENGINEER

determines that the methods proposed are not sufficient to ensure the proper proportions, hydration, and dispersion of backfill components, CONTRACTOR shall change methods and repeat the demonstration at CONTRACTOR's sole expense.

6. The proportions of materials for each step shall be based on CONTRACTOR's mix design adjustable for field conditions.
7. Mix backfill at a moisture content to produce a mix having the consistency and appearance of wet concrete. The slump of the mixture, when measured in accordance with ASTM C143, shall generally be from 3 to 6 inches. Mix backfill into a homogeneous mass, free from large lumps or pockets of fines, sand, or gravel, or stones larger than 3 inches in their largest dimension.

C. Placing:

1. Place backfill so that no air pockets are present in the completed excavation. Vibrate the backfill as necessary to prevent hollows or trapped pockets of air and to move backfill into all areas.
2. Do not drop backfill, or deposit it in any manner that may cause segregation.
3. Surface of backfill is to be smooth and free of pockets that may prevent contact with geosynthetic clay liner (GCL).

3.5 MAINTENANCE OF BACKFILL

A. After backfill of any portion of the excavation is complete, maintain the backfill in an undamaged condition until covered with the GCL. Portions of the backfill intended to remain that dry, crack, desiccate, or are damaged in any other way shall be corrected by removing all desiccated or otherwise unacceptable backfill to a depth acceptable to DESIGN ENGINEER and placing of fresh backfill on the excavated surface to the final grade.

3.6 CLEANUP

A. After completion of backfilling operations, all remaining excavated material and backfill shall be removed from the ground surface in the construction area. The excess materials shall be disposed of within the disposal areas shown or at the location designated by RESIDENT ENGINEER. RESIDENT ENGINEER shall be the sole judge of satisfactory cleanup, and cleanup shall be performed until accepted by RESIDENT ENGINEER.

3.7 QUALITY CONTROL SAMPLING AND TESTING

A. CONTRACTOR shall perform the sampling and control testing specified below, according to the methods specified below, and at the frequencies specified below. Sampling and testing shall be performed by personnel experienced in the type of test required. Samples shall be representative of the overall volume of material from which the sample is taken. Equipment for sampling and testing shall be in good condition. Equipment shall be set up for onsite testing and tests shall be performed onsite unless otherwise specified or accepted in writing by DESIGN ENGINEER. Tests shall be performed in a timely manner and the results immediately submitted in writing to DESIGN ENGINEER. Test results shall become the property of

OWNER. CONTRACTOR shall be responsible for representative, quality, and accurate sampling and testing. Mathematical calculations shall be checked by someone other than the person performing the original calculations.

Material	Sampling And Testing	Frequency
Imported Fines Fine-Grained Material	Samples as delivered to site Percent passing No. 200 Atterberg limits Moisture content	Every 100 cu yd
Backfill - Immediately Prior to Placing in Excavation	Random sample Percent passing No. 200 Grain size distribution Moisture content Slump Unit weight Permeability compressive strength	Every 100 cu yd

B. Tests shall conform to the following standards:

Test	Standard
Percent passing No. 200 sieve	ASTM D1140
Grain size distribution	ASTM C136
Moisture content	ASTM D2216
Atterberg limits	ASTM D4318
Slump	ASTM C143
Unit weight of backfill	ASTM C138
Bentonite content	API RP 13B
Permeability	ASTM D2434
Compressive strength	ASTM C39

C. DESIGN ENGINEER may sample and test independently of CONTRACTOR. DESIGN ENGINEER's work will be in addition to that specified and shall not relieve CONTRACTOR of any testing responsibilities.

D. Whenever tests conducted by CONTRACTOR or DESIGN ENGINEER indicate material or workmanship not in accordance with the Contract Documents, work shall be halted and the cause of the discrepancy shall be identified. Work not in accordance with the Contract Documents shall be removed, replaced, repaired, or otherwise corrected so as to conform to these Contract Documents.

E. Sampling and testing performed by CONTRACTOR, work necessary to identify the cause of any nonconformance, and remedial work necessary

because of construction not in accordance with the Contract Documents shall be at CONTRACTOR's sole expense.

END OF SECTION

SECTION 02403
REINFORCED CONCRETE CUTOFF WALL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work necessary for construction of the reinforced concrete cutoff wall, complete.

1.2 DEFINITIONS

A. Slurry Method of Excavation: Excavation of a vertical-walled trench in the soil and rock while at the same time keeping the trench filled with a specified bentonite slurry. The basic purpose of the slurry is to support the walls of the trench.

B. Slurry Trench: A trench excavated in the ground by the slurry method of excavation.

C. Reinforced Concrete Cutoff Wall: A continuous low-permeability water and erosion barrier formed by backfilling a slurry trench with the specified reinforced concrete mixture.

D. Heading: Any continuous section of slurry trench which is being excavated at one end and/or backfilled at the other end.

E. Working Surface: The ground surface elevation adjacent to the top of the slurry trench during excavation of the slurry trench.

F. Groundwater Level: The piezometric level of the groundwater as determined from piezometers installed in the alluvium in the vicinity of the slurry trench.

G. Well-Graded: Well-graded as used in this section defines a mixture of particle sizes that have no specific concentration or deficiency of one or more sizes. Well-graded is used to help define a material that, when placed in the slurry trench, produces a relatively impermeable material free from detrimental voids.

H. Ravelling: Loss of ground from the trench walls not caused by equipment operation that results in widening of the trench beyond the specified width.

I. API: American Petroleum Institute.

J. API RP: API Recommended Practice.

K. Unclassified Excavation: Removal of all material encountered regardless of the geologic formation, degree of induration, hardness, or other property.

L. Fines: Material passing the U.S. Standard No. 200 sieve, when tested in accordance with ASTM C117.

M. GCL: Geosynthetic clay layer. As specified in this section.

N. Geologic Bedrock: Natural, indurated geologic formations underlying the loose, uncemented river alluvium. Geologic bedrock includes materials such as granite, sandstone, and conglomerate occuring in ledges or layers. The term does not include boulders or other particles contained within the alluvium.

1.3 QUALIFICATIONS FOR REINFORCED CONCRETE CUTOFF WALL CONTRACTOR

A. CONTRACTOR shall be experienced in reinforced conrete cutoff wall construction, and shall have sufficient competent personnel experienced in this type of construction and able to carry out the operations specified. CONTRACTOR shall have experience in previous successful projects of reinforced concrete cutoff walls using specialized slurry trench construction equipment to depths of 20 feet or greater, and with excavation in rock. Also, a slurry trench and reinforced concrete cutoff wall specialist shall be employed by CONTRACTOR to control the composition, mixing, placing, cleaning, and maintaining of the slurry and reinforced concrete backfill.

B. The slurry trench and reinforced concrete cutoff wall specialist shall be an engineer or engineering technician who has had proven and successful experience with 20-foot deep slurry trench construction, using specialized slurry trench construction equipment, and who is knowledgeable and experienced with all facets of the construction including, but not limited to:

1. The use, testing, and control of bentonite as a slurry.
2. The proper mixing methods employed to mix the slurry and concrete backfill material.
3. Excavation and backfill operations.
4. A thorough knowledge of construction equipment and testing requirements needed for slurry trench construction.
5. Placement of joints in concrete backfill.
6. Placement of reinforcing steel and connection of adjacent panels.

1.4 SUBMITTALS

A. Certification, test results, and samples for all imported material, including bentonite.

B. Catalog and manufacturer's data sheets for slurry trench excavating equipment, slurry mixing and placing equipment, and compaction equipment.

C. Plan for mixing slurry and delivery of slurry to trench.

D. Plan for placement of reinforcing steel.

E. Plan for placement of joints.

F. Plan for mixing and placing concrete backfill.

G. Test results for design mix of concrete backfill including permeability, slump, moisture content, grain size distribution, and strength.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide all labor, materials, and equipment necessary to accomplish the work specified in this section.

2.2 HYDRAULIC EXCAVATION FOR TRENCH EXCAVATION

A. The backhoe shall have a rated bucket curling force of not less than 40,000 pounds, and a rated stick crowd force of not less than 35,000 pounds. Forces shall be determined in accordance with PCSA Standard No. 3. The backhoe shall be in good condition and equipped with the manufacturer's standard length stick, the manufacturer's standard short radius bucket, general-duty ripper and rock points, or equivalent equipment.

2.3 CUTOFF TRENCH BACKFILL

A. The concrete backfill mix shall be designed by CONTRACTOR. The mix backfill shall meet the following requirements:

1. Concrete shall conform to the requirements of Section 03300, CAST-IN-PLACE CONCRETE. Steel reinforcement shall conform to the requirements of Section 03210, REINFORCING STEEL.
2. Submit a concrete mix design report prepared under the supervision of and sealed by a professional engineer licensed in the State of Arizona, with at least 5 years of experience in slurry wall design and construction. The mix design report shall show the results of various tests at varying proportions of the concrete materials, so as to identify an appropriate mix to achieve the properties specified.
3. DESIGN ENGINEER reserves the right to increase the amount of cement to be added to the mixed backfill up to 3 percentage points over the amount recommended in the mix design report if field conditions require to achieve consistency.

2.4 BENTONITE

A. Pulverized or powdered premium grade natural sodium cation bentonite, conforming to the requirements of the standards of API Specifcation 13A, with a minimum yield of 90 barrels per ton when tested in accordance with API RP 13B. Protect bentonite from moisture and contamination in transit and in storage at the site.

2.5 ADMIXTURES

A. The use of any admixture, or of any plugging or bridging agent, will not be permitted without prior written authorization from DESIGN ENGINEER.

2.6 SLURRY

A. The slurry for supporting the sides of the trench and for mixing with the backfill shall consist of a stable colloidal suspension of bentonite in water. Design the slurry such that it has the density, viscosity, and filtrate loss necessary to maintain the stability of the excavated trench.

B. The in-trench slurry shall meet the following as determined in accordance with API RP 13B:

1. Viscosity: Minimum of 40 sec. Marsh.
2. Filtrate Loss: Maximum of 25 cubic centimeters.
3. Density of Slurry Sampled: At least 15 pcf lighter than the concrete backfill when sampled within 5 feet of trench bottom.

2.7 WATER

A. Use only potable water to form the slurry and soil-bentonite backfill.

B. Potable water will be provided by OWNER, as specified in Section 01500, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS.

2.8 IMPORTED MATERIAL ACCEPTANCE

A. Other than bentonite, all imported materials specified in this section are subject to the following requirements:

1. All tests necessary for CONTRACTOR to locate an acceptable source of imported material shall be made by CONTRACTOR. Certification that the material conforms to the Specification requirements along with copies of the test results from a qualified commercial testing laboratory shall be submitted to DESIGN ENGINEER for approval at least 10 days before the material is required for use. All samples shall be furnished by CONTRACTOR at CONTRACTOR's sole expense. Samples shall be representative and be clearly marked to show the source of the material and the intended use on the project. Sampling of the source shall be done by CONTRACTOR in accordance with ASTM D75. Notify DESIGN ENGINEER at least 24 hours prior to sampling. DESIGN ENGINEER may observe the sampling procedures. Tentative acceptance of the source shall be based on an inspection of the source by DESIGN ENGINEER and/or the certified test results submitted by CONTRACTOR at DESIGN ENGINEER's discretion. No imported materials shall be delivered to the site until the proposed source and materials tests have been tentatively accepted in writing by DESIGN ENGINEER. Final acceptance will be based on tests made on samples of material taken

from CONTRACTOR's onsite stockpile. All testing for final acceptance shall be performed by DESIGN ENGINEER.

2. Tests by CONTRACTOR shall be made on samples taken at the place of production prior to shipment. Tests shall be as specified for the material in question. Samples of the finished product for testing shall be taken from each 100 cubic yards of material or more often as determined by DESIGN ENGINEER, if variation in gradation is occurring, or if the material appears to depart from the Specifications. Test results shall be presented in writing to DESIGN ENGINEER within 48 hours after sampling.
3. If tests conducted by CONTRACTOR or DESIGN ENGINEER indicate that the material does not meet Specification requirements, material placement shall terminate until corrective measures are taken. Material that does not conform to the Specification requirements and that has been placed in the work shall be removed and replaced at CONTRACTOR's sole expense. Sampling and testing performed by CONTRACTOR shall be done at CONTRACTOR's sole expense.

2.9 BENTONITE ACCEPTANCE

A. Submit to DESIGN ENGINEER certification from the manufacturer that the bentonite conforms with API Specification 13A and these Specifications prior to placing orders.

B. Submit samples of bentonite to DESIGN ENGINEER for tentative acceptance prior to placing orders. Samples shall be representative and clearly marked to show the source of the material and the intended use on the project. Final acceptance of bentonite shall be based on tests made on samples of bentonite taken from CONTRACTOR's onsite bentonite storage facilities. All testing for final acceptance will be performed by DESIGN ENGINEER.

2.10 EQUIPMENT

A. All equipment shall be maintained and operated in strict accordance with the manufacturer's instructions and recommendations. All equipment shall be free of fluid leaks which discharge substances onto the ground or into the trench. Immediately repair or remove from the site all broken or leaky lines, hoses, valves, pistons, pipes, tanks, and other equipment components. Equipment shall be maintained in such condition that it will deliver the manufacturer's rated output. If inadequate quantity or quality of production is obtained, provide larger and/or different equipment.

B. Slurry Trench Excavating Equipment: Equipment for excavating the slurry trench shall consist of either a hydraulic backhoe, a trenching machine adopted for slurry trench construction, a special mechanical slurry trench clamshell, or other specialized equipment for slurry trench construction. The buckets used in the equipment shall not be perforated and shall be made to minimize the ravelling of the sides of the trench and to maintain the width of the trench. The equipment shall be capable of excavating the minimum required trench width in a single pass of the excavating tool through all soil and up to 5 feet into bedrock.

C. Slurry Mixing and Placing Equipment: The slurry plant shall include a high-speed colloidal mixer, or other equipment that achieves complete dispersion of the bentonite particles and produces a stable colloidal suspension of bentonite and water. The plant shall be capable of providing a continuous supply of slurry to the slurry trench during excavation. Provide all necessary sumps, pumps, hoses, valves, supply lines, mixers, tools, and all other items necessary to adequately supply slurry for the Work.

D. Slurry Storage Facilities: If necessary to provide time for complete hydration of the bentonite in the slurry, provide storage tanks or construct storage ponds to store freshly mixed slurry. Storage facilities shall be configured so as to allow continuous low-speed circulation of the stored slurry. Storage ponds may not be constructed inside the area confined by the soil-bentonite cutoff wall.

E. Concrete Backfill Mixing and Placing Equipment: Equipment for mixing and placing concrete backfill shall be a suitable type of tremie pumping equipment capable of forcing the concrete to the bottom of the trench and displacing the bentonite slurry.

F. Moisture Control Equipment: Equipment for applying water shall be of a type and quality adequate for the Work, shall not leak, and shall be equipped with a distributor bar or other approved device to assure uniform application. Equipment for mixing and drying out material shall consist of blades, discs, or other approved equipment.

2.11 QUALITY CONTROL EQUIPMENT

A. CONTRACTOR's Equipment: Provide all equipment necessary for CONTRACTOR's quality control testing. Minimum quality control testing by CONTRACTOR is specified hereinafter. Provide any additional equipment necessary for any additional testing CONTRACTOR elects to do. All equipment shall be maintained in good working order, and shall meet the requirements of the applicable test standards cited herein.

B. Equipment for Use of DESIGN ENGINEER: Provide the following equipment for use by DESIGN ENGINEER during the Work. Equipment shall be furnished to DESIGN ENGINEER not less than 5 working days prior to initial slurry mixing for the project. All equipment shall be in good working order, and shall be maintained in good working order by CONTRACTOR at his own expense. DESIGN ENGINEER will take ordinary and reasonable care of CONTRACTOR-furnished equipment, and will return all such equipment to CONTRACTOR at the completion of the work in the condition received, less normal wear and tear inherent to the work. Provide the expendable supplies listed in quantities shown. CONTRACTOR-furnished expendable supplies not used in quality control testing of the work will be returned to CONTRACTOR at the completion of the work. Additional or other expendable supplies will be purchased by DESIGN ENGINEER.

Item No.	Item	Quantity	Expendable Supplies
1.	Marsh Funnel Set (API RP 13B)	1	None
2.	Mud Balance (API RP 13B)	1	None
3.	Slurry Sampler, capable of obtaining 1 U.S. quart or more of slurry from any given depth in the trench or from the slurry storage facilities, with necessary rods, poles, etc.	1	None
4.	Filter press for low temperature test, 100 psi maximum pressure, compressed gas pressurization system, with necessary gas cylinders, regulator, etc. (API RP 13B)	1	Compressed gas sufficient for 100 tests; filter paper conforming to API RP 13B for 100 tests
5.	Filter press for low temperature test, 100 psi maximum pressure, no pressurization system required (API RP 13B)	4	None
6.	Trench depth measuring device of appropriate length for the work, with knots or projecting markers at 5-foot vertical intervals	1 per heading	None

PART 3 EXECUTION

3.1 EXCAVATION–GENERAL

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered. Make own estimate of the kind and extent of the various materials to be excavated in order to accomplish the work. Some rock excavation will be required.

3.2 EXCAVATION SAFETY

A. CONTRACTOR shall be solely responsible for making the excavation in a safe manner. Provide appropriate measures to retain excavation side slopes, to prevent slope failures, and to ensure that persons at or near the excavation are protected.

3.3 DEPTH OF EXCAVATION

A. Excavate to the depths as shown or as determined in the field by DESIGN ENGINEER.

B. In general, the depth of the trench shall be determined as follows:

1. Where the Drawings show the trench penetrating into the top of geologic bedrock, the specified hydraulic excavator shall be used to excavate into the top of bedrock up to 5 feet, after removal of the alluvium. If any 10-foot horizontal reach of the trench bottom cannot be advanced to this depth within 1 hour of continuous excavation operations, the trench bottom shall be cleaned of loose material and shall be completed at the elevation so achieved. Use metal pole or rod with a steel point to probe the bottom of the trench and verify the trench bottom cleanliness. Allow DESIGN ENGINEER to use the probe rod to verify that the cleanup is satisfactory. Satisfactory cleanup of the bottom means that no discrete particle of movable material can be felt with the probe rod when manually manipulated from the top of the trench.
2. Where the Drawings show the trench bottom not extending into bedrock, excavate the trench to the depth shown. If geologic bedrock is encountered at an elevation higher than the trench bottom shown, complete the trench into of the geologic bedrock as specified in the preceding paragraph.

C. The locations where geologic bedrock is anticipated are shown on the dam geologic profile. Descriptions of the geologic bedrock materials are provided in the supplementary information referred to in Division 1, GENERAL REQUIREMENTS.

3.4 CONSTRUCTION PAD

A. In areas where the surface and near-surface soils are inadequate to form the top of the slurry trench, or where groundwater is too close to the surface for trench stability, or where there is inadequate width on which to work, or where necessary to permit grade changes, or where elected by CONTRACTOR, build a construction pad as necessary to complete the slurry trench. The dimensions and details of the construction pad shall be determined by CONTRACTOR. All construction pad work other than at required grade changes shall be at CONTRACTOR's option. After backfilling of the slurry wall in any area is complete, the construction pad shall be removed.

3.5 TOLERANCES

A. Alignment of the cutoff wall shall be within 1 foot of alignment shown. Requests for greater variations shall be submitted to DESIGN ENGINEER for review at least 2 weeks prior to excavation in the area of the proposed change.

B. The wall shall be plumb within 3 degrees of vertical.

3.6 LIMITS OF EXCAVATION

A. Excavation carried below the grade line shown or established by DESIGN ENGINEER shall be backfilled with concrete as specified for the remainder of the trench. Correct all overexcavated areas at CONTRACTOR's sole expense.

3.7 EXCESS EXCAVATION DISPOSAL

A. Dispose of all excess excavation in the excess disposal areas shown, or as directed by RESIDENT ENGINEER.

3.8 SLURRY MIXING

A. Produce slurry by gradually adding dry bentonite to potable water and thoroughly mixing until a complete dispersion of bentonite is achieved. The resulting slurry shall have a bentonite content adequate to produce the slurry properties specified herein before introduction into the trench.

B. After mixing, allow the slurry to hydrate completely before being introduced to the trench excavation. This may be accomplished by maintaining high speed circulation until hydration is complete, or by storing the slurry in a tank or pond with a low speed circulation system. The slurry shall be stored under essentially constant circulation until used. Circulation may cease overnight or on weekends when the addition of slurry to the trench is not necessary.

C. Hydration will be considered to be complete when filtrate loss and viscosity reaches the specified limits, and when filtrate loss and viscosity is stable when measured one or more hours apart, as determined by DESIGN ENGINEER.

D. Newly mixed slurry that is not completely hydrated shall be segregated from hydrated slurry, and shall not be commingled with other slurry.

E. All slurry shall be batched or continuously mixed. No slurry shall be mixed in the trench.

F. Hydrated slurry shall have the specified properties before being delivered to the trench. Hydrated slurry shall not be thinned by the addition of water or otherwise altered before being introduced into the trench.

G. CONTRACTOR's full-time slurry trench specialist shall regularly test and control the mixing and placing of the slurry in order to maintain the specified properties of the slurry. Submit a plan to DESIGN ENGINEER for mixing the slurry and delivery to the trench.

3.9 SLURRY TRENCH EXCAVATION

A. The working surface for the slurry trench shall be located at the elevations of the bottom of the adjacent slab, except where higher elevations are required for stability or construction access, and such higher grades are authorized in writing by DESIGN ENGINEER.

B. Excavate the trench using the slurry method of excavation. Excavate to the depth as hereinbefore specified. Excavate to full depth at the starting point, then carry the trench excavation along the trench alignment at the full depth shown or required. The walls of the trench shall be essentially vertical.

C. The trench shall be excavated and backfilled with slurry in a continuous process during each normal work day without voluntary interruption until it is complete.

D. Construction surcharges including, but not limited to, excavated material, slurry mixing operations, backfill mixing operations, excavating equipment, and pumping equipment, shall be kept away from the trench. Only equipment required for excavation and backfilling shall be allowed adjacent to the trench.

E. Provide stabilizing measures to prevent ravelling at the top of the trench. This might include, but is not limited to, placing a compacted soil cap on the ground surface in the vicinity of the slurry trench. The stabilizing method used shall be reviewed by DESIGN ENGINEER prior to use.

F. Introduce slurry into the trench at the time excavation begins. Maintain the level of the slurry in the open trench at all times at least 3 feet above the groundwater level and not more than 1 foot below the working surface. Prevent dilution of slurry by surface waters. Maintain slurry at all times in the specified condition. To achieve this end, the slurry may require operations such as recirculation through shaker screens or cyclone-type desanders, or other techniques.

G. If it is necessary for any portion of the wall to be excavated and backfilled in more than one continuous segment, re-excavation of the previously constructed reinforced concrete wall will be necessary. This re-excavation shall consist of removal 10 feet perpendicular to the slope of the backfill for the full depth of the wall. That portion of the wall that is removed or overlapped shall be reconstructed at CONTRACTOR's own expense, unless DESIGN ENGINEER or OWNER has requested in writing that the wall be constructed in more than one continuous segment.

3.10 BACKFILL TRENCH IN CASE OF HIGH WATER

A. In the event of a flood or prolonged precipitation where the groundwater level rises within 3 feet of the top of the working surface, DESIGN ENGINEER may require CONTRACTOR to stop excavation and to begin continuous operations to either dike around the open trenches and raise the slurry level, to lower the groundwater in the vicinity of the trench by use of wells or wellpoints.

3.11 TRENCH BOTTOM CLEANING AND SAMPLING

A. Sand and sediment that settles out of the slurry or falls to the bottom of the trench shall be removed by a clamshell, an airlift pump, or other suitable equipment whenever material is settling to the bottom of the trench. The clamshell, airlift pump, or other equipment shall be operated in a manner that prevents removal of material from the walls of the trench. Material removed from the trench shall be placed in the excess excavation disposal area.

B. When excavation in any portion of the trench is complete, check the continuity of the trench by passing the excavating tool or a probe rod completely through the entire portion of the trench just completed. Coordinate such checking with DESIGN ENGINEER so that DESIGN ENGINEER may witness the checking.

C. After the trench bottom has been cleaned, take at least one sample of the native material in the trench bottom every 25 feet along the length of the slurry wall. Samples shall be obtained using a split-spoon sampler (ASTM D1586), a clamshell bucket, or backhoe bucket. Split-spoon samples shall have a minimum length of 3 inches. Provide 1 pint glass jars for all samples, clearly mark sample location and date, and store samples in a neat and orderly manner until completion of the Project. After examining these samples, DESIGN ENGINEER will either accept termination of the excavation at the elevations sampled, or require additional excavation. If additional excavation is required, then additional samples shall be furnished by CONTRACTOR using the same procedures.

D. Backfill of the trench that has been cleaned and accepted by DESIGN ENGINEER as soon as practicable, but in no case more than 24 hours after DESIGN ENGINEER's acceptance.

3.12 BACKFILLING

A. General: Do not begin backfilling any portion of the trench until such portion has been cleaned, sampled, and accepted by DESIGN ENGINEER.

B. Construct reinforced concrete cutoff wall in panels approximately 10 feet in length and 4 feet in width in a "leap frog" sequence or in alternate sequence approved by DESIGN ENGINEER. Construct panels such that keyways are formed between panels using pipes, H-piles, circular stop ends, triangular tongue and groove, or other technique approved by DESIGN ENGINEER. CONTRACTOR shall maintain strength, integrity, and continuity of panel joints.

C. Placing Steel Reinforcement:

1. Place steel reinforcement conforming to Section 03210, REINFORCING STEEL.
2. Install spacers on external reinforcing bars on reinforcing cage to ensure proper centering of the reinforcing cage in the slurry wall and proper concrete coverage of the steel on the external face of the wall.
3. Handle reinforcing cages so as not to kink or permanently bend cage. Damaged cages will not be acceptable.
4. Set reinforcing cage at required location and elevation prior to placing backfill concrete. Hold and support such that it does not move during concrete backfill operations.

D. Placing Concrete:

1. Place concrete backfill in panels using the tremie methods so that no pockets of slurry are present in the completed concrete cutoff wall.

Maintain bottom of tremie pipe at least 10 feet below top of concrete until pour is completed. Backfill continuously from the beginning of the heading in the direction of the excavation to the end of the heading. Placing operations shall proceed in such fashion that the top of the backfill below the surface of the slurry shall follow a reasonably smooth grade and shall not have hollows that may trap pockets of slurry. Rod the face of the backfill below the surface of the slurry as necessary to prevent hollows or trapped pockets of slurry.

2. Do not drop concrete backfill, or deposit it in any manner that may cause segregation. Free-dropping of concrete backfill material through the slurry is prohibited.
3. After concrete has set, remove keyway construction materials. Remove contaminated materials from panel connection joints with scratcher or other device.

3.13 MAINTENANCE OF TOP OF CUTOFF WALL

A. After concrete backfill of any portion of the trench is complete, maintain the concrete backfill in an undamaged condition and at or below the bottom of the adjacent slab. Remove all portions of the concrete backfill that cracks, desiccates, or are damaged in any other way by removing all desiccated or otherwise unacceptable backfill to a depth acceptable to DESIGN ENGINEER and immediately placing fresh concrete backfill on the excavated surface to the final cutoff wall grade. Maintain rebar and top of concrete until concrete for adjacent slab is in place. Form top 2 feet of cutoff wall below finshed adjacent grade.

3.14 CLEANUP

A. After completion of backfilling operations, all remaining excavated material, slurry, and concrete shall be removed from the ground surface in the construction area including the mixing areas. The excess materials shall be disposed of within the disposal areas shown or at the location designated by RESIDENT ENGINEER. Dispose of the slurry by spreading it on the ground and mixing it into the top foot of surface soil by disking or other appropriate means. Allow slurry to dry as necessary for thorough mixing. All areas where slurry has been stored, ponded, or spilled shall be cleaned. The cleanup shall consist of removal of the slurry and soil mixed with slurry. RESIDENT ENGINEER shall be the sole judge of satisfactory cleanup, and cleanup shall be performed until accepted by RESIDENT ENGINEER.

3.15 QUALITY CONTROL SAMPLING AND TESTING

A. Perform the sampling and control testing specified below, according to the methods specified below, and at the frequencies specified below. Sampling and testing shall be performed by personnel experienced in the type of test required. Samples shall be representative of the overall volume of material from which the sample is taken. Equipment for sampling and testing shall be in good condition. Equipment shall be set up for onsite testing and tests shall be performed onsite unless otherwise specified or accepted in writing

by DESIGN ENGINEER. Tests shall be performed in a timely manner and the results immediately submitted in writing to DESIGN ENGINEER. Test results shall become the property of OWNER. CONTRACTOR shall be responsible for representative, quality, and accurate sampling and testing. Mathematical calculations shall be checked by someone other than the person performing the original calculations.

Material	Sampling And Testing	Frequency
Slurry - As mixed	Sampled immediately before entering trench Unit weight Moisture content Viscosity Filtrate loss	Every 10,000 gal.
Slurry - In-Trench	Sampled from random depths (record depth) Unit weight Viscosity Filtrate loss Percent passing No. 200	Twice daily
Slurry - In-Trench Immediately Prior to Rebar Placement or Concrete Backfill	Sampled within 5 feet of base Unit weight Viscosity	Every 100 LF
Concrete Backfill - Immediately Prior to Placing in Trench	Random sample Slump Compressive strength Unit weight	Every 100 cu yd

B. Tests shall conform to the following standards:

Test	Standard
Unit weight of slurry	API RP 13B
Moisture content	ASTM D2216
Viscosity, Marsh-sec	API RP 13B
Filtrate loss	API RP 13B
Slump	ASTM C143
Unit weight of backfill	ASTM C138
Compressive strength of concrete	ASTM C39

C. DESIGN ENGINEER may sample and test independently of CONTRACTOR. DESIGN ENGINEER's work will be in addition to that specified and shall not relieve CONTRACTOR of any testing responsibilities.

D. Whenever tests conducted by CONTRACTOR or DESIGN ENGINEER indicate material or workmanship not in accordance with the Contract Documents, work shall be halted and the cause of the discrepancy shall be identified. Work not in accordance with the Contract Documents shall be removed, replaced, repaired, or otherwise corrected so as to conform to these Contract Documents.

E. Sampling and testing performed by CONTRACTOR, work necessary to identify the cause of any nonconformance, and remedial work necessary because of construction not in accordance with the Contract Documents shall be at CONTRACTOR's sole expense.

END OF SECTION

SECTION 02585
PIEZOMETERS

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers the Work necessary for furnishing and installing piezometers. The DESIGN ENGINEER will designate 10 locations at the downstream dam and 3 locations at the upstream dam where piezometers are to be installed. Piezometer locations will be near horizontal concrete surfaces at finished grade.

PART 2 PRODUCTS

2.1 GENERAL

A. All equipment and materials shall be in good operating condition at all times and operated and maintained in strict conformance with manufacturers' recommendations.

B. Install all piezometers at the appropriate locations shown on the Drawings or as determined in the field by the DESIGN ENGINEER. Provide all materials required to accomplish the work as specified.

C. The CONTRACTOR shall have the appropriate equipment and trained personnel to perform piezometer installation and development work as specified herein.

2.2 PIEZOMETERS

A. Piezometers shall consist of standard 2-inch diameter factory slotted PVC threaded pipe, with 0.02-inch size openings, 30 inches in length, as manufactured by Timco Manufacturing Company, Inc., Prairie du Sac, WI, or equal; attached to 2-inch Schedule 80 PVC pipe with flush threaded couplings.

B. CONTRACTOR shall design a cap common to all piezometers and submit drawings to DESIGN ENGINEER for review. Cap shall be heavy steel, galvanized after fabrication and sufficiently durable to withstand flood water and cobble collisions. Caps shall seal piezometer pipes from surface water and shall be removable using normal hand tools. Design shall be revised in accordance with review comments.

2.3 GRAVEL PACK

A. Gravel pack shall be thoroughly washed, hard, durable well-rounded rock, or siliceous material. The gravel pack shall be free of organic material, anhydrite, gypsum, mica, or calcareous material. The specific gravity of the material shall not be less than 2.5 as determined by ASTM D854.

B. The size and gradation of the gravel pack material shall be determined by the DESIGN ENGINEER on the basis of formation samples taken by the CONTRACTOR during drilling. For bidding purposes, assume Monterey sand 8x16 grade and for the grouted solid pipe and assume the gravel pack material around the perforated piezometer tip shall pass the No. 4 sieve and be retained in the No. 30 sieve.

C. Submit to the DESIGN ENGINEER certified laboratory test results verifying conformance of the gravel pack material to the specifications along with the 5-pound sample of the material before it is delivered to the site.

2.4 GROUT MIX

A. Grout around the solid pipe shall consist of a cement/sand/bentonite slurry. Proportion one bag of cement to not more than 6 gallons of water; 4 to 5 pounds of powdered bentonite per bag of cement may be used to reduce shrinkage. Add sand as appropriate. Consistency and method of mixing shall be approved by the DESIGN ENGINEER. The use of special cements or other admixtures (ASTM C494) to reduce permeability, increase fluidity, and/or control set time, and the composition of the resultant slurry shall be approved by the DESIGN ENGINEER. The time between mixing and placement and the total volume of slurry emplaced shall also be recorded by the CONTRACTOR.

B. The cement shall conform to ASTM Designation C150 Type I or II portland cement.

C. Bentonite for the grout mix shall be a high swelling finely ground sodium montmorillinite such as produced by American Colloid Company, Skokie, IL, or equal.

D. Water used for mixing of grout shall be potable water, with its source accepted by the RESIDENT ENGINEER.

E. Grout mix shall consist of 1:1 ratio (dry volume) granular bentonite (No. 8 size chips) and 8x16 grade Monterey sand.

2.5 SOUNDING DEVICE

A. Provide a measuring device to sound the gravel/grout seal level in the hole during and after placement.

PART 3 EXECUTION

3.1 INSTALLING PIEZOMETERS

A. Borings shall be drilled to depths as determined by the DESIGN ENGINEER up to a maximum of 40 feet. Borehole construction shall be by downhole hammer, rotary, or by alternate method as accepted by the DESIGN ENGINEER.

B. Where the bottom of the piezometer is higher than the bottom of the boring, the lower portion of the boring shall be sealed by pumping or tremieing a bentonite-cement-sand grout through a pipe placed at the bottom of the boring and withdrawing the casing to the top of the seal. The bentonite-cement-sand grout shall be allowed to set a minimum of 12 hours or to a suitable hardness as determined by the DESIGN ENGINEER before overlying gravel is placed. This grout mixture may contain a quicksetting agent to decrease the setting time. The required setting period shall depend on the type of setting agent used and must be acceptable to the DESIGN ENGINEER.

C. The piezometer tip, PVC pipe of length determined by the DESIGN ENGINEER, sand, bentonite pellets, and grout shall be installed to the top of the borehole as directed by the DESIGN ENGINEER. Pipe joints shall be made secure and watertight. While withdrawing temporary steel drill casing during pipe installation, care shall be taken to minimize the increments of temporary casing withdrawal so that collapse of the borehole does not occur. Gravel pack and bentonite pellets shall be placed slowly enough so that bridging does not occur in the boring, and so as to prevent the piezometer from being lifted as the temporary casing is withdrawn. Grout above the bentonite pellets shall be a bentonite-cement-sand grout, pumped or tremied through a pipe placed at the top of the bentonite seal. The installation shall be directed and approved by the DESIGN ENGINEER.

D. Each piezometer shall be developed upon completion of the installation by air development or bailing until at least five well columns have been removed or upon approval of the DESIGN ENGINEER.

E. A rising head or falling head sensitivity test shall be performed as determined by the DESIGN ENGINEER after the installation has been completed to ensure that the piezometer is working properly.

END OF SECTION

SECTION 02830
ORNAMENTAL GATES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work necessary to furnish and install, complete, ornamental gate and hardware at the Upstream Dam Control Building.

1.2 SUBMITTALS

A. Shop Drawings: Submit shop drawings and installation drawings for the ENGINEER's review prior to fabrication and delivery. These drawings shall provide detailed information and specifications for all materials, finishes, dimensions, and erection and installation instructions.

B. Samples: Custom color match for ENGINEER's approval. Color matching is critical to meet City-approved color and design concepts. Nonmatching of color will be cause for rejection. Color match Dunn-Edwards Q1-58T, Impala.

1.3 QUALITY ASSURANCE

A. The design, supply of equipment and components and installation shall be the product of an individual company with a record of installations meeting the requirements herein specified. Design shall include the wind loadings shown on the Drawings.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name is for the purpose of establishing the standard of quality. Products of other manufacturers will be considered in accordance with the General Conditions.

B. Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

C. Materials shall be new and products of recognized, reputable manufacturers. Used, rerolled, or regalvanized materials are not acceptable.

D. All materials shall be hot-dip galvanized after fabrication. All connectors and fasteners shall be prepunched before galvanizing. All tubing shall be galvanized and finished both inside and out. All materials shall be coated with electrostatic-applied polyester powder coating. All materials shall be factory finished. Color shall match Dunn-Edwards Q1-58T, Impala.

2.2 ORNAMENTAL GATES

A. Gate: Fabricated of welded steel with 2-inch square tube steel frame and 1-inch square tube pickets, configuration and size as shown on Drawings.

B. Hinges: Heavy-duty, ball bearing, barrel hinge type. Size and spacing as required for gate weight.

C. Latch: Mortise deadlock with hookbolt. Install in frame member. Deadlock shall be similar to Adams Rite MS-1890. Cylinder by others.

D. Jambs: 2-inch square tube with capped ends. Drill elongated drip hole in bottom. Anchor to CMU as shown on Drawings. Provide closed box strike.

E. Finish: Powder polyester coating on gate and jambs.

F. Manufacturers:

1. Builders Fence Company, Inc., Sun Valley, California.
2. Boundary Fence and Railing Systems, Inc., Richmond Hill, New York.
3. Ametco/Orsogril Products, Willoughby, Ohio.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install ornamental gate following manufacturer's recommendations and instructions.

B. Furnish all equipment and accessories necessary for complete installation.

C. Coordinate with hardware supplier of cylinder lock as necessary.

D. Coordinate with mason for required masonry reinforcing and preparation.

3.2 CLEANUP

A. Upon completion of the fence installation, clean up all waste material resulting from the operation.

END OF SECTION

SECTION 03100
CONCRETE FORMWORK

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Layout of panel joints, tie hole pattern.
2. Form Ties—Tapered Through-Bolts: Proposed method of sealing form tie hole; coordinate with details shown.
3. Layout of "wave wall" at the Downstream Dam Control Building. Submittal shall be presented for approval drawn at 1/2-inch to 1-foot 0-inch scale at a 6-inch grid. Configuration shall approximate that shown on Drawings.

B. Samples: One each as follows:

1. Form ties.

C. Quality Control Submittals:

1. Statements of qualification for formwork designer.
2. Manufacturer's Certificate of Proper Installation in accordance with Section 01640, MANUFACTURERS' SERVICES.

1.2 QUALITY ASSURANCE

A. Qualifications: Formwork, falsework, and shoring designs prepared by an engineer licensed in the state of Project.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 SYSTEM DESIGN REQUIREMENTS

A. Design formwork in accordance with ACI 347-89 and ACI 318-89 to provide the concrete finishes specified in Section 03300, CAST-IN-PLACE CONCRETE.

B. Make joints in forms watertight.

C. Limit panel deflection to 1/360 of each component span to achieve tolerances specified.

3.2 FORM MATERIALS

A. Wall Forms and Underside of Slabs and Beams:

1. Materials: Plywood, hard plastic finished plywood, or steel in "new and undamaged" condition, of sufficient strength and surface smoothness to produce specified finish.

B. Column Forms:

1. Rectangular Columns and Pilasters: As specified for walls.
2. Circular Columns and Pilasters: Fabricated steel with bolted together sections or seamless cardboard column forms continuous for height of column.

C. All Other Forms: Materials as specified for wall forms.

D. Form Sealer:

1. Material: Surface sealer will not bond with, stain, or adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces when applied to most forms. A ready-to-use water based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Environmentally safe, meeting local, state, and federal regulations.
2. Manufacturer and Product: Master Builders, Inc.; Rheofinish.

E. Reveal Grooves and Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

F. Form Ties:

1. Material: Steel.
2. Spreader Inserts:
   a. Conical or spherical type.
   b. Design to maintain positive contact with forming material.
   c. Furnish units that will leave no metal closer than 1 inch to concrete surface when forms, inserts, and tie ends are removed.
3. Wire ties not permitted.
4. Flat bar ties for panel forms, furnish plastic or rubber inserts with minimum 1-inch depth and sufficient dimensions to permit patching of tie hole.
5. Water Stop Ties: For recycle pump station, water-holding structures, basements, and accessible spaces below finish grade, furnish one of the following:
   a. Integral steel water stop 0.103-inch thick and 0.625 inch in diameter tightly and continuously welded to tie.

b. Neoprene water stop 3/16-inch thick and 15/16 inch in diameter whose center hole is 1/2 diameter of tie, or a molded plastic water stop of comparable size.
c. Water Stop: Oriented perpendicular to tie and symmetrical about center of tie.
d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.

6. Through-Bolts: Tapered minimum 1-inch diameter at smallest end.
7. Elastic Vinyl Plug: Design and size of plug to allow insertion with tool to enable plug to elongate and return to original length, and diameter upon removal forming a watertight seal.
   a. Manufacturer and Product: Dayton Superior Co., Miamisburg, OH; Dayton Sure Plug.

3.3 ERECTION

A. General: Unless specified otherwise, follow the applicable recommendations of ACI 347-89.

B. Beveled Edges (Chamfer):

1. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
2. Where beveled edges on existing adjacent structures are other than 3/4 inch, obtain RESIDENT ENGINEER's approval of size prior to placement of beveled edge.

C. Wall Forms:

1. Do not reuse forms with damaged surfaces.
2. Locate form ties and joints in an uninterrupted pattern for smooth and uniform surface.
3. Inspect form surfaces prior to installation to assure conformance with specified tolerances.

D. Forms for Curbs, Sidewalks, and Driveways:

1. Provide standard steel or wood forms to prevent movement.
2. Set forms to true lines and grades, and securely stake in position.

E. Form Tolerances: Provide forms in accordance with ACI 347-89 and ACI 318-89 and the following tolerances for finishes specified:

1. Wall Tolerances:
   a. Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance specified.
   b. Plumb within 1/4 inch in 10 feet or within 1/2 inch from top to bottom.
      1) Depressions in Wall Surface: Maximum 1/8 inch when 10-foot straightedge is placed on high points in all directions.

c. Thicknesses: Maximum 1/4 inch minus or 1/2 inch plus from dimensions shown.

2. Slab Tolerances:
   a. Exposed Slab Surfaces: Comprise of flat planes as required within tolerances specified.
   b. Slab Finish Tolerances and Slope Tolerances: Crowns on floor surface not too high as to prevent 10-foot straightedge from resting on end blocks, nor low spots that allow a block of twice the tolerance in thickness to pass under the supported 10-foot straightedge.
   c. Slab steel gauge block 1/4 inch thick.
   d. Finish Slab Elevation: Slope slabs to adequately drain regardless of tolerances.
   e. Foundation Slab for Rubber Dams: In the contact area of the inflated dam, maximum plus or minus 1/4 inch from true elevation shown for full length of each dam segment between piers or abutment.
   f. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown, except where thickness tolerance will not affect slope, drainage, or slab elevation.
3. Beams and Columns Tolerances:
   a. Exposed Straight Horizontal and Vertical Surfaces: Flat planes within tolerances specified.
   b. Beam:
      1) Physical Dimensions: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
      2) Elevations: Within 1/2 inch plus or minus except where tops of beams become part of finished slab. In this case refer to slab tolerances.
   c. Column:
      1) Physical Dimensions: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
      2) Plumb within 1/4 inch in 10 feet in all directions with maximum 1/2 inch out-of-plumb at top with respect to bottom.

3.4 FORM SURFACE PREPARATION

A. Thoroughly clean form surfaces in contact with concrete or previous concrete, dirt, and other surface contaminants prior to coating surface.

B. Exposed Wood Forms in Contact with Concrete: Apply form sealer as recommended by the sealer material manufacturer.

C. Steel Forms: Apply form sealer to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.

3.5 FORM REMOVAL

A. Formwork not supporting weight of concrete, (i.e., sides of beams, walls, columns, and similar parts of the Work) may be removed after cumulatively

curing at not less than 50 degrees F for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.

B. Leave forms and shoring for elevated structural slabs or beams in place, in accordance with ACI 318-89, Chapter 6, and until concrete has reached compressive strength equal to 80 percent of the specified 28-day compressive strength as determined by test cylinders.

END OF SECTION

SECTION 03210
REINFORCING STEEL

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Prepare in accordance with CRSI 1990 Manual of Standard Practice and ACI SP-66 Detailing Manual:
   a. Bending lists.
   b. Placing drawings.
2. Welded splice, Cadweld splice, and mechanical threaded splice.

B. Quality Control Submittals:

1. Lab test reports for reinforcing steel showing stress-strain curves and ultimate strengths.
2. Mechanical Threaded Connections:
   a. Current International Conference of Building Officials (ICBO) Research Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions.
   b. Manufacturer's instructions.
   c. Verification that device threads have been checked and meet all requirements for thread quality, in accordance with manufacturer's published methods.
3. Welding Qualification: Prior to welding, submit welder qualifications and radiographic nondestructive testing procedures.
4. Test results of field testing.

1.2 QUALITY ASSURANCE

A. Welder Qualifications: Certified in accordance with AWS D1.4-79.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Unload, store, and handle bars in accordance with CRSI publication "Placing Reinforcing Bars."

PART 2 PRODUCTS

2.1 MATERIALS

A. Deformed Billet-Steel Reinforcing Bars:

1. Includes stirrups, ties, and spirals.
2. ASTM A615-90, Grade 60, including Supplemental Requirements S1 where welding is not required.
3. ASTM A706/A706M-90, Grade 60, including Supplemental Requirements for reinforcing to be welded.

B. Splices and Mechanical Connections:

1. Mechanical Threaded Connections: Furnish metal coupling sleeve for splicing reinforcing in secondary members or in areas of low stress with internal threads engaging threaded ends of bars developing in tension or compression 125 percent of yield strength of bar.
   a. Manufacturers and Products:
      1) Erico Products, Inc., Cleveland, OH; Lenton Reinforcing Steel Couplers.
      2) Richmond Screw Anchor Co., Inc., Fort Worth, TX; Richmond DB-SAE Dowel Bar Splicers.

C. Welded Wire Fabric:

1. ASTM A185-90a or A497-90b and ACI 318/318R-89, using ASTM A82-90a wire of 75 ksi minimum tensile strength.
2. Furnish flat sheets only, rolled sheets not permitted.

2.2 ACCESSORIES

A. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-, epoxy-, or plastic-coated wire.

B. Bar Supports and Spacers:

1. Precast concrete bar supports, cementitious fiber-reinforced bar supports, or all-plastic bar supports and side form spacers meeting the requirements of CRSI Manual of Standard Practice. Do not use other types of supports or spacers.
2. In Beams, Columns, Walls, and Slabs Exposed to View After Stripping: Small rectangular concrete blocks made up of same color and strength as concrete being placed around them or all-plastic bar supports and side form spacers.
3. Precast concrete supports of same strength as concrete for reinforcing in concrete placed on grade.

2.3 FABRICATION

A. Follow CRSI Manual of Standard Practice.

B. Bend all bars cold.

PART 3 EXECUTION

3.1 PREPARATION

A. Notify RESIDENT ENGINEER when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.

B. Clean metal reinforcement of loose mill scale, oil, earth, and other contaminants.

C. Coat wire projecting from precast concrete bar supports with dielectric material, epoxy, or plastic.

3.2 REINFORCING BAR INSTALLATION

A. Bundle or space bars, instead of bending where construction access through reinforcing is necessary.

B. Spacing and Positioning: Conform to ACI 318/318R-89.

C. Location Tolerances: In accordance with CRSI publication, "Placing Reinforcing Bars".

D. Splicing:

1. Follow ACI 318/318R-89.
2. Use lap splices unless otherwise shown or permitted in writing by RESIDENT ENGINEER.
3. Welded Splices: Accomplish by full penetration groove welds and develop at least 125 percent of yield strength of bar.
4. Stagger splices in adjacent bars.

E. Mechanical Splices and Connections:

1. Use only in areas specifically approved in writing by the RESIDENT ENGINEER.
2. Install as required by manufacturer with threads tightened and in accordance with ICBO Research Report.
3. Maintain minimum edge distance and concrete cover.

F. Tying Deformed Reinforcing Bars:

1. Tie every other intersection on mats made up of Nos. 3, 4, 5, and 6 bars to hold them firmly at required spacing.
2. Bend all tie wire to prevent tie wire from being closer than 1 inch from the surface of concrete.

G. Welding Reinforcement:

1. Only A706/A706M-90 bars may be welded.
2. Do not perform welding until welder qualifications are approved.

H. Straightening and Rebending: Field bending of reinforcing steel bars is not permitted.

I. Unless permitted by RESIDENT ENGINEER, do not cut reinforcing bars in the field.

3.3 WELDED WIRE FABRIC INSTALLATION

A. Use only for reinforced slabs on grade.

B. Extend fabric to within 2 inches of edges of slab, and lap splices at least 1-1/2 courses of fabric or minimum 8 inches.

C. Tie laps and splices securely at ends and at least every 24 inches with tie wire.

D. Place welded wire fabric on concrete blocks at correct distance as shown, above bottom of slab and rigidly support equal to that provided for reinforced bars. Do not use broken concrete, brick, or stone.

E. Follow ACI 318/318R-89 and current Manual of Standard Practice, Welded Wire Fabric.

F. Do not use fabric that has been rolled. Install flat sheets only.

3.4 TESTS AND INSPECTION

A. Test all welds using radiographic, nondestructive testing procedures referenced in AWS D1.4-79.

B. Inspect each splice and verify each component is in accordance with manufacturer's instructions and ICBO Research Report.

END OF SECTION

SECTION 03215
DOWELING FOR CONCRETE AND CSA

PART 1 GENERAL

1.1 DEFINITIONS

A. ICBO Reports: Published by ICBO for concrete anchor manufacturers.

B. Special Inspection: As governed by the ICBO UBC-94.

1.2 SUBMITTALS

A. Shop Drawings: Technical data for epoxy adhesive, vinyl ester adhesives, grouts, and bonding agents.

1. Mixed Adhesive: Current test data indicating cured adhesive meets or exceeds design loads required.

B. Samples: Two random Samples of each batch of products delivered to site, for independent testing.

C. Quality Control Submittals:

1. Manufacturer's specific instructions for preparation, placement, drilling of holes, installation of anchors and epoxy or vinyl ester, and handling of cartridges, nozzles, and equipment.
2. Manufacturer's qualifications, to include client name, address, contact person, phone number, project location, and description of work.
3. Manufacturer's Certificate of Proper Installation.
4. Manufacturer's written letter of certification identifying installer's qualifications to install products.
5. Doweling system manufacturer's ICBO Reports.
6. Provide detailed step-by-step instructions for the Special Inspection procedure in accordance with ICBO Reports and Section 1701 of UBC-94.
7. Copy of manufacturer's operation and repair manuals for each type of equipment delivered to site.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: At least three similar projects with same products within the last 3 years.
2. Installer: Trained and certified by manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Epoxy Components:

1. Store epoxy components on pallets or shelving in a covered storage area.
2. Control temperature above 60 degrees F and dispose of product if shelf life has expired.
3. Dispose of product if stored at other than manufacturer's instructions.
4. Container Markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

B. Vinyl Ester Products:

1. Store components on pallets or shelving in a covered storage area with locking door.
2. Control temperature within 41 to 77 degrees F and dispose of product if shelf life has expired.
3. Dispose of product if stored at other than manufacturer's instructions.
4. Container Markings: Include manufacturer's name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

PART 2 PRODUCTS

2.1 EPOXY ADHESIVES

A. General:

1. Meet ASTM C881-90, Type 1, Grade 3, Class A, B, or C, depending on site conditions.
2. Two-component, 100 percent solids, nonsag, paste, insensitive to moisture, designed to be used in adverse environments and gray in color.
3. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
4. Mixing: Follow manufacturer's instructions.

B. Component "A" Base Resin: Modified biphenyl-A type epoxy.

1. Viscosity: Light paste, 350 cps maximum prior to mixing to ensure proper wetting of moist concrete surfaces.
2. Fillers: 100 percent solids, fumed silica and selected annular micro silica powders. Do not use micro spheres, fly ash, or Asbestos.
3. Color: White.

C. Component "B" Hardener or Curing Agent:

1. Viscosity: Light paste.
2. Fillers: 100 percent solids, fumed silica and selected annular micro silica powders. Do not use micro spheres, fly ash, or Asbestos.

3. Color: Black.

D. Mixed Epoxy Adhesive:

1. Nonsag light paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without runout, holding the following properties:
   a. Slant Shear Strength, ASTM C881-90/882-91, No Failure In Bond Line, Dry/Moist Conditions: 5,000 psi.
   b. Compressive Strength, ASTM D695-90: 14,000 psi, minimum.
   c. Tensile Strength, ASTM D695-90: 4,500 psi.
   d. Heat Deflection Temperature, ASTM D648-82e: 135 degrees F, minimum.
2. Manufacturers and Products:
   a. Adhesives Technology Corp., Kent, WA 98031; Anchor-It Fastening Systems, HS 200 Epoxy Resin; telephone 1-800/262-4748.
   b. ITW Ramset/Red Head, Wood Dale, IL 60191; Epcon Ceramic 6 Epoxy Anchor System.
   c. Covert Operations, Long Beach, CA, 90853; CIA Epoxy Anchors with viscosity to suit application.

2.2 VINYL ESTER ADHESIVES

A. Materials:

1. Two-component, insensitive to moisture, designed to be installed in adverse environments.
2. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.

B. Manufacturer and Product: HIT Doweling Anchor System (HIT C-100), by Hilti, Inc., Tulsa, OK 74146.

2.3 ANCHOR RODS

A. Reinforcing Bars: As specified in Section 03210, REINFORCING STEEL.

PART 3 EXECUTION

3.1 GENERAL

A. Dispensing, Metering, or Mixing Epoxy Adhesive Components: Use portable, automatic metering and mixing device or machine capable of maintaining prescribed mix ratio within deviation of 5 percent or less, by volume. Do not use epoxy where fire or temperatures above 100 degrees F can occur.

B. Install in accordance with manufacturer's specific instructions.

C. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.

D. Mixing Nozzles:

1. Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.
2. Nonremovable internal static mixer required to ensure proper blending of components.

E. Where large meter and mixing pumps are impractical, provide adhesive packaged as follows:

1. Disposable, self-contained cartridge system capable of dispensing both components in the proper mixing ratio, and fit into a manually or pneumatically operated caulking gun.
2. Dispense components through a mixing nozzle that thoroughly mixes components and places adhesive at base of predrilled hole.
3. Mixing Nozzles:
   a. Disposable, manufactured in several sizes to accommodate sizes of reinforcing dowels.
   b. Nonremovable internal static mixer required to ensure proper blending of components.

3.2 TESTING OF AUTOMATIC METERING AND MIXING DEVICES

A. Tests for Proper Ratio:

1. Retain small amount of dispensed adhesive for inspection after each time the pump is refilled.
2. Check these Samples for color change.
3. Should change in color occur, follow manufacturer's service instructions to obtain proper operation.

B. Frequency of Tests: Make full ratio check after each 100 gallons of adhesive is dispensed or if color of mixed adhesive becomes noticeably darker or lighter.

C. Ratio Check Procedure:

1. Disconnect dispensing head behind ON/OFF valve.
2. Place volume containers of the required proportions under the "B" and "A" component hose ends.
3. Actuate the pump.
4. Both cups should fill in an equal time, thereby verifying the proportion ratio by volume.

3.3 DOWEL SIZING AND INSTALLATION

A. Follow adhesive manufacturer's instructions for installation.

B. Drilling Equipment:

1. Drilling Hammers for Dowel Holes: Electric or pneumatic rotary type with medium or light impact.
2. Hollow drills with flushing air systems are preferred.
3. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.

C. Hole Diameter:

1. As small as possible to allow dowel to be embedded to required depth.
2. Use drill bit diameter meeting ICBO Report requirements.
3. Epoxy Adhesive: Dowel diameter plus 1/8 inch for ambient temperature at time of installation above 60 degrees F, or dowel diameter plus 1/4 inch for ambient temperature at time of installation below 60 degrees F.
4. For large reinforcing bars No. 8 or greater embedded 18 diameters or more, verify hole diameter with manufacturer.
5. Vinyl Ester Adhesive: As recommended by manufacturer.

D. Obstructions in Drill Path:

1. When existing reinforcing steel is encountered during drilling and when approved by the ENGINEER, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter; or redrill hole 1 inch from original location, beginning in the same line at the surface, redirecting the drill to miss reinforcing steel.
2. Place dowels in both the misdrilled hole and the new one.
3. When using epoxy anchors, dowels may be prebend prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
4. Bent Bar Dowels: Where edge distances are critical, and striking reinforcing steel is likely, drill hole at 10-degree angle or less and use prebend reinforcing bars.

3.4 CSA ANCHOR DOWEL PULLOUT TESTS

A. Test 5 percent of anchors to verify adequate pullout resistance.

B. RESIDENT ENGINEER will determine which anchors shall be tested.

C. Test anchors after grout has achieved 4,000 psi compressive strength.

D. Apply test load in tension equal to 80 percent of yield strength of bar. Maintain load for minimum of 10 minutes. If bar moves while maintaining test load, or if application of full test load is not possible, anchor will be rejected.

E. Test Apparatus: Conform to ASTM D4435-84 for each of the following items:

1. Loading system.
2. Load transducer.
3. Displacement transducer.
4. Displacement transducer support.

F. Load measurement systems shall be calibrated by independent testing laboratory and accurate to within plus or minus 5 percent of actual load.

G. Method of load application shall not damage bar.

H. Install replacement anchors for each failed anchor at location determined by RESIDENT ENGINEER.

I. Retest one additional anchor bar for each failed bar in addition to number initially required.

3.5 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at site in accordance with Section 01640, MANUFACTURERS' SERVICES, for installation assistance, inspection, and certification of proper installation.

END OF SECTION

SECTION 03251
EXPANSION, CONSTRUCTION, AND CONTROL JOINTS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Plastic Type Water Stops: Details of splices to be used and method of securing water stop in the forms and supporting water stop so as to maintain proper orientation and location during concrete placement.
2. Construction Joints: Layout and location indicating type to be used.
3. Joint fillers for horizontal and sloped joints.
4. Water stop.

B. Samples: Splice, joint, and fabricated cross of each size, shape, and fitting of water stop(s) proposed for use.

C. Quality Control Submittals:

1. Water stop manufacturer's written instructions for product shipment, storage, handling, installation field splices, and repair.
2. Joint Filler and Primer: Manufacturer's written instructions for product shipment, storage, handling, application, and repair.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site: Verify that water stops delivered are in accordance with cross-section dimensions as shown and manufacturer's product data prior to unloading and storing onsite.

PART 2 PRODUCTS

2.1 PLASTIC WATER STOP

A. Extruded from an elastomeric plastic compound of which the basic resin shall be polyvinyl chloride (PVC). Reclaimed PVC in the compound is not acceptable.

B. Specific Gravity: Approximately 1.37.

C. Shore Durometer Type A Hardness: Approximately 80.

D. Performance Requirements: Corps of Engineers' Specification CRD-C-572.

E. Type: Center bulb with a number of parallel ribs or protrusions on each side of strip center.

F. Corrugated or tapered type water stops are not acceptable.

G. Thickness: Constant from bulb edge to the outside stop edge.

H. Minimum Weight per Foot of Water Stop:

1. 0.90 pound for 3/16 inch by 4 inch.
2. 1.62 pounds for 3/8 inch by 6 inch.
3. 2.30 pounds for 3/8 inch by 9 inch.

I. Manufacturers and Catalog Numbers:

1. Vulcan Metal Products, Inc., Construction Materials Division, Birmingham, AL; Catalog No. 3/81-15M: Type 8067 (4 inch by 3/16 inch), Type 8069 (6 inch by 3/8 inch), and Type 8070 (9 inch by 3/8 inch).
2. Vinylex Corp., Knoxville, TN; Catalog No. 03250/VIN (1987): No. RB6-38H (6 inch by 3/8 inch) and No. RB9-38H (9 inch by 3/8 inch).
3. Greenstreak Plastic Products, St. Louis, MO; Catalog No. 03250/GRD (1987): Style 732 (6 inch by 3/8 inch) and Style 735 (9 inch by 3/8 inch).
4. A. C. Horn, Inc., Beltsville, MD; Catalog No. CSP-162 (1987): Type 3 (4 inch by 3/16 inch), Type 9 (6 inch by 3/8 inch), and Type 10 (3/8 inch by 9 inch).

2.2 WIRE LOOPED PLASTIC WATER STOP

A. Furnish as an alternative to plastic water stops.

B. Same material and geometry as plastic water stops.

C. Furnish with continuous galvanized wire looping at edge for convenience in positioning and securing stop in place in the forms.

D. Manufacturers and Catalog Numbers: Paul Murphy Plastics, Roseville, MI; "Wire Stop Water Stop"; geometry numbers ACR 6380, ACR 9380, as shown on Paul Murphy Plastics Co. Drawing No. CCP-120-12M dated 12-89.

2.3 GASKET WATER STOP

A. Manufacturers and Products:

1. BBZ, U.S.A., Southing, CT; Duroseal Gasket Waterstop, Type W.
2. Greenstreak, St. Louis, MO; Hydrotite CJ 1030

2.4 BOND BREAKER

A. Tape for Expansion Joints: Adhesive-backed glazed butyl or polyethylene tape, same width as the joint, that will adhere to the premolded joint material or concrete surface.

B. Use either bond breaker tape or a bond prevention material as specified in Section 03300, CAST-IN-PLACE CONCRETE, except where a tape is specifically called for.

2.5 PREMOLDED JOINT FILLER

A. Bituminous Type: ASTM D994-71e or D1751-83.

B. Sponge Rubber: Neoprene, closed-cell, expanded; ASTM D1056-85, Type 2C5, with a compression deflection, 25 percent deflection (limits), 119 to 168 kPa (17 to 24 psi) minimum.

1. Manufacturer and Product: Rubatex Corp.; R45IN.

2.6 POURABLE JOINT FILLERS

A. Specific Gravity: Greater than 1.0 for cured, in-place filler.

B. Sloped Joints: Furnish Gun Grade material that will remain as placed in joints and will not run down slope.

C. Manufacturers and Products:

1. W. R. Meadows, Inc., Elgin, IL.: No. 164 Polymeric sealing compound, hot-pour, or Hi-Spec Polymeric joint sealing, hot-pour compound; or
2. A. C. Horn, Inc., North Bergen, NJ.: No-Track two-component material (Code 2323), cold-applied, self-leveling filler; or
3. W. R. Meadows, Elgin, IL.: Gardox, two-component, cold-applied compound filler.

2.7 STEEL EXPANSION JOINT DOWELS

A. Dowels: ASTM A36-90 round smooth steel bars.

B. Bar Coating: Two-coat System No. 29A, FUSION BONDED, STEEL DOWEL COATING, as specified in Section 09900, PAINTING, with a factory-applied lubricating coating.

2.8 ACCESSORIES

A. Joint Sealants: As specified in Section 07900, JOINT SEALANTS.

B. Nonshrink Grout:

1. As specified in Section 03600, GROUT.
2. Compatible with joint sealant.

C. Roofing Felt: ASTM D226-89, Type II, 30-pound asphalt-saturated or equal weight of ASTM D227-89 coal-tar saturated felt.

D. Reinforcing Steel: As specified in Section 03210, REINFORCING STEEL.

E. Nails: As required for securing bituminous type premolded joint filler.

F. Masking Tape: As required to temporarily adhere to concrete at each side of joint to receive filler.

PART 3 EXECUTION

3.1 GENERAL

A. Construct straight joints; make vertical or horizontal, except where walls intersect sloping floors.

B. Commence concrete placement after the joint preparation is complete.

C. Time Between Concrete Pours: As specified in Section 03300, CAST-IN-PLACE CONCRETE.

3.2 SURFACE PREPARATION

A. Construction Joints: Prior to placement of abutting concrete, clean contact surface:

1. Remove laitance and spillage from reinforcing steel and dowels.
2. Roughen surface to a minimum of 1/4-inch amplitude:
   a. Sandblast after the concrete has fully cured.
   b. Water blast after the concrete has partially cured.
   c. Green cut fresh concrete with high pressure water and hand tools.
3. Perform cleaning so as not to damage water stop, if one is present.

B. Expansion Joint with Pourable Filler:

1. Use motorized wire brush or other motorized device to mechanically roughen and thoroughly clean concrete surfaces on each side of joint from plastic water stop to the top of the joint.
2. Use clean and dry high pressure air to remove dust and foreign material, and dry joint.
3. Prime surfaces before placing joint filler.
4. Avoid damage to water stop.

C. Expansion Joint without Pourable Filler:

1. Coat concrete surfaces above and below plastic water stop with bond breaker.
2. Do not damage water stop.

D. Control Joint:

1. Coat concrete surface above and below plastic water stop with bond breaker.
2. Do not damage water stop.
3. Furnish correct type and size of reinforcing and dowels.

3.3 INSTALLATION OF WATER STOPS

A. General:

1. Join water stops at intersections to provide continuous seal.
2. Center water stop on joint.
3. Secure water stop in correct position to avoid displacement during concrete placement.
4. Repair or replace damaged water stop.
5. Place concrete and vibrate to obtain impervious concrete in the vicinity of all joints.
6. Joints in Footings and Slabs:
   a. Ensure that space beneath plastic water stop is completely filled with concrete.
   b. During concrete placement, make a visual inspection of the entire water stop area.
   c. Limit concrete placement to elevation of water stop in first pass, vibrate the concrete under the water stop, lift the water stop to confirm full consolidation without voids, then place remaining concrete to full height of slab.
   d. Apply procedure to full length of plastic water stops.

B. Plastic Water Stop:

1. Install in accordance with manufacturer's written instructions.
2. Splice in accordance with the water stop manufacturer's written instructions using a thermostatically controlled heating iron. Butt splice unless specifically detailed otherwise.
   a. Allow at least 10 minutes before the new splice is pulled or strained in any way.
   b. Finished splices shall provide a cross-section that is dense and free of porosity with tensile strength of not less than 80 percent of the unspliced materials.
3. Wire looped plastic water stop may be substituted for plastic water stop.

C. Gasket Water Stop:

1. Install between reinforcing steel and wet face of wall unless shown otherwise.

2. Use manufacturer's standard adhesive to attach to joint surface.

3.4 EXPANSION JOINT INSTALLATION

A. General:

1. Place bond breaker above and below water stop when premolded joint filler and pourable joint filler is not used.
2. Premolded Joint Filler:
   a. Sufficient in width to completely fill the joint space where shown.

b. If a water stop is in the joint, cut premolded joint filler to butt tightly against the water stop and the side forms.

3. Precut premolded joint filler to the required depth at locations where joint filler or sealant is to be applied.
4. Form cavities for joint filler with either precut, premolded joint filler, or smooth removable accurately shaped material. Entire joint above water stop, in slabs, shall be formed and removed so that entire space down to water stop can be filled with the pourable joint filler.
5. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface.

B. Bituminous Type Premolded Joint Filler:

1. Drive nails approximately 1 foot 6 inches on center through the filler, prior to installing, to provide anchorage embedment into the concrete during concrete placement.
2. Secure premolded joint filler in forms before concrete is placed.
3. Install in walkways, at changes in direction, at intersections, and at 45-foot intervals, maximum.

C. Pourable Joint Filler:

1. General: Install in accordance with the manufacturer's written instructions, except as specified below:
   a. Apply primer prior to pouring joint filler.
   b. Fill entire joint above the water stop with joint filler as shown.
   c. Use masking tape on top of slabs at sides of joints; clean spillage. Remove masking tape afterwards.
2. Rubber Asphalt Type, Hot-Applied:
   a. Heat filler material in a double-walled boiler.
   b. Place filler in the joint by means of a nozzle from a portable pouring type container to prevent spillage outside of the joint.
   c. Begin pouring joint filler at the bottom of the horizontal joint and proceed upwards in a manner that will preclude the possibility of trapping air in the joint.
3. Rubber Asphalt Type, Cold-Applied: Place cold-applied, two-component fillers in accordance with manufacturer's written instructions.
4. Multicomponent Type: Install in accordance with manufacturer's written instructions.

D. Steel Expansion Joint Dowels:

1. Install coated and lubricated bars parallel to wall or slab surface and in true horizontal position perpendicular to the joint in both plan and section view, so as to permit joint to expand or contract without bending the dowels.
2. Secure dowels tightly in forms with rigid ties.
3. Install reinforcing steel in the concrete as shown to protect the concrete on each side of the dowels and to resist any forces created by joint movement.

3.5 CONTROL JOINT INSTALLATION

A. Locate reinforcing and dowels as shown.

B. Concrete surfaces shall be dense and smooth.

C. Install bond breaker to concrete surfaces above and below water stop.

END OF SECTION

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 DEFINITIONS

A. Architectural Concrete: Concrete surfaces that are exposed and can be seen inside or outside of structures regardless whether concrete is above water, dry at all times, or can be seen when structure is drained.

B. Mass Concrete: Concrete sections that are 24 inches and greater in thickness or depth.

C. *Defective* Areas: Surface defects that include honeycomb, rock pockets, indentations, cracks 0.005-inch wide and larger, and cracks that leak in water-retaining structures, spalls, chips, air bubbles, pinholes, bug holes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins and other projections, form popouts, texture irregularities, and stains and other color variations that cannot be removed by cleaning.

D. New Concrete: Less than 60 days old.

E. MAG: Maricopa Association of Governments Uniform Standard Specifications for Public Works Construction.

1.2 SUBMITTALS

A. Administrative Submittals: Preinstallation conference minutes.

B. Shop Drawings:

1. Product Data: Admixtures, bonding agent, bond breaker, and patching materials.
2. Design Data: Concrete mix designs signed by qualified mix designer.
3. Placement Drawings: Concrete, identifying location of each type of construction joint.
4. Gradation for coarse and fine aggregates, and combined together. List gradings, percent passing through each sieve size.
5. Detailed plan for cold weather curing and protection of concrete placed and cured in weather below 40 degrees F.

C. Samples:

1. One sample of each type of aggregate proposed for use for sandblast finish and exposed aggregate finish. Gradation shall be as intended for use.
2. Prior to starting work on mockup panels, submit Sample for exposed aggregate finish 24 inches by 24 inches square by 1-1/2 inches thick.
3. Demonstrate the use of bonding admixtures proposed for use.

D. Quality Control Submittals:

1. Manufacturer's application instructions for bonding agent, and bond breaker.
2. Proposed application schedule and instructions for patching materials.
3. Manufacturers' Certificate of Compliance:
   a. Cement used in architectural concrete.
   b. Portland cement.
   c. Admixtures.
   d. Fly ash.
   e. Aggregates.
   f. Bonding agent.
   g. Bond breaker.
   h. Patching materials.
4. Admixtures: Manufacturers' Certificate of Proper Installation.
5. Statements of Qualification:
   a. CONTRACTOR's resident superintendent for concrete installation.
   b. Mix designer.
   c. Batch plant.
6. Test Reports:
   a. Admixtures, test reports showing chemical ingredients and percentage of chloride in each admixture and fly ash.
   b. Source test analysis report for fly ash.
   c. Statement identifying aggregates reactivity and aggregate effects on concrete finish and appearance. Showing total chloride in each component of aggregates utilizing grinding to 50-mesh screen and determination of total chloride. Use Florida DOT method.
   d. For each trial mix design and signed by qualified mix designer.
   e. Cylinder test results from laboratory mixes.
   f. Concrete shrinkage test results.
7. Concrete Delivery Tickets:
   a. For each batch of concrete before unloading at site.
   b. Record of drum revolution counter, type, brand, test certification, and amount of fly ash if used in accordance with ASTM C94-90, Section 16.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. CONTRACTOR's Resident Superintendent for Concrete Installation:
   a. Supervised successful construction of at least three large volume concrete projects in similar environmental conditions.
2. Mix Designer: Licensed professional engineer registered in the state of Project.
3. Batch Plant: Currently certified by the National Ready Mixed Concrete Association.

B. Mockup Panels:

1. Construct one panel for each type of wall and exposed aggregate slab finish. Mock-up panels for sloping concrete shall be cast in a sloping position to simulate actual conditions. Panels shall be cast under actual job conditions.
2. Minimum dimensions for each panel 10 feet by 10 feet.
   a. Demonstrate sandblasting techniques, in prescence of RESIDENT ENGINEER, to show how uniform appearance will be achieved regardless of age of concrete.
3. The wall panels shall be used as a means determining the degree of sandblasting acceptable to OWNER. The exposed aggregate panel shall be used to determine the appearance of the finished surface and the depth of exposure that will be the basis for the work.
4. Before concrete work starts, construct panels with specified materials, forming systems, reinforcing details, and leakage prevention techniques.
5. Show architectural details, joints, chamfers, form ties, recesses, and rebar spacers to produce finished surface required.
6. Test form sealer on one wall mockup panel to assure no adverse effects affect form materials.
7. Cast panels from minimum of 3-cubic-yard truck mixer load.
8. Surface finish uniform in appearance as Samples.
9. Panels shall establish standards of quality by which concrete work will be judged.
10. Replace panels if not representative of Work as specified.
11. Panels shall be used as a means to demonstrate and refine patching and repair methods and means. Construct additional 8-foot by 8-foot panel to develop and test patching techniques and mixes.
12. Mockup panels shall remain in place during construction for reference, and shall be removed completely upon completion of the Work with approval of RESIDENT ENGINEER. Restore casting surfaces as required.

C. Preinstallation Meetings:

1. Required Meeting Attendees:
   a. CONTRACTOR.
   b. Ready-mix producer.
   c. Admixture representative.
   d. Testing personnel.
   e. RESIDENT ENGINEER.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify RESIDENT ENGINEER of location and time.
3. Agenda shall include:
   a. Admixture types, dosage, performance, and redosing at site.
   b. Mix designs, test of mixes, and Submittals.
   c. Placement methods, techniques, equipment, consolidation, and form pressures.
   d. Slump and placement time to maintain slump.
   e. Finish, curing, and water retention.
   f. Other specified requirements requiring coordination.
4. Conference minutes as specified in Section 01040, COORDINATION.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Cold Weather Placement:

1. Do not place concrete when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling, without special protection as specified or approved by RESIDENT ENGINEER.
2. Do not place concrete against frozen earth or ice, or against forms and reinforcement with frost or ice present.
3. Provide heated enclosures when air temperatures are below 40 degrees F.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cement: Furnish from one source.

1. Portland Cement Type II:
   a. Meet ASTM C150-89.
   b. Alkalies: Maximum 0.60 percent.

B. Aggregates: Furnish from one source.

1. Natural Aggregates:
   a. Free from deleterious coatings and substances in accordance with ASTM C33-90, except as modified herein.
   b. Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
2. Nonpotentially Reactive: In accordance with ASTM C33-90, Appendix XI, paragraph X1.1.
3. Aggregate Soundness: Test for fine and coarse aggregates in accordance with ASTM C33-90 and ASTM C88-90 using sodium sulfate solution.
4. Fine Aggregates:
   a. Clean, sharp, natural sand.
   b. ASTM C33-90.
   c. Materials Passing 200 Sieve: 4 percent maximum.
   d. Limit deleterious substances in accordance with ASTM C33-90, Table 1 with material finer than 200 sieve limited to 3 percent, coal and lignite limited to 0.5 percent.
5. Coarse Aggregate:
   a. Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
   b. Materials Passing 200 Sieve: 0.5 percent maximum.
   c. Limit deleterious substances in accordance with ASTM C33-90, Table 3 for exposed architectural concrete.
6. Special Aggregates for Seeded Exposed Aggregate Finish:
   a. Uniform, hard, sound, and clean rounded river gravel.
   b. 3/8-inch natural round.

C. Admixtures: Furnish from one manufacturer.

1. Characteristics: Compatible with each other and free of chlorides or other corrosive chemicals.
2. Air-Entraining Admixture:
   a. ASTM C260-86, nontoxic after 30 days and contain no chlorides.
   b. Concrete with air-entrainment admixture added shall maintain air percentage as batched, within plus or minus 2 percent for time required for placement into structure.
3. Water-Reducing Admixtures: ASTM C494-90, Type A or Type D.
   a. Manufacturers and Products:
      1) Master Builders, Inc., Cleveland, OH; Pozzolith or Pozzolith Polyheed.
      2) W. R. Grace & Co., Cambridge, MA; WRDA HYCOL or WRDA-64.
      3) Euclid Chemical Co., Cleveland, OH; Eucon WR-90.
4. Superplasticizers:
   a. ASTM C494-90.
   b. Hold slump of 5 inches or greater for time required for placement into structure with water-cement ratio.
   c. Furnish type as recommended by manufacturer for allowed temperature ranges.
   d. Type F or G.
   e. Manufacturers and Products:
      1) Master Builders, Inc., Cleveland, OH; Rheobuild or Pozzolith Polyheed at dosage greater than 10 ounces per 100 pounds of cement.
      2) W. R. Grace & Co., Cambridge, MA; Daracem 100 or WRDA-19.
      3) Euclid Chemical Co., Cleveland, OH; Eucon Super F or 537G.
      4) No "or-equal" or substitute products will be considered.
5. Pozzolan (Fly Ash): Class F fly ash in accordance with ASTM C618-91, Table 1 and 2, except as modified herein:
   a. Loss on Ignition: Maximum 3 percent.
   b. Water Requirement: Maximum 100 percent of control.
   c. $\frac{CaO\ (\%)-5}{Fe_2O_3(\%)}$: Maximum 1.5
   d. ASTM C618-91, Table 1A apply when aggregates or portion of coarse or fine aggregates used are reactive as specified under paragraph Aggregates.
   e. ASTM C618-91, Table 2A, Reactivity with Cement Alkalies, apply when aggregates or portions of aggregates are reactive as specified under paragraph Aggregates.
   f. ASTM C618-91, Table 2A, Uniformity Requirements, apply when loss on ignition of fly ash furnished exceeds 3 percent.
6. For fly ash not meeting the requirements of the chemical ratio listed above, furnish the following:
   a. Test fly ash in accordance with ASTM C1012-89.
   b. Furnish test data confirming fly ash in combination with cement used meets strength requirements and is compatible with air-entraining agents and other additives.

D. Water: Clean and potable containing less than 50 ppm of chlorides.

2.2 ANCILLARY MATERIALS

A. Bonding Agent: Furnish as recommended by manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.

1. Manufacturers:
   a. Master Builders Technologies, Cleveland, OH.
   b. Sika Chemical Corp., Lyndhurst, NJ.
   c. Euclid Chemical Co., Cleveland, OH.

B. Bond Breaker: Nonstaining type, providing a positive bond prevention.

1. Manufacturers and Products:
   a. Williams Distributors, Inc., Seattle, WA; Williams Tilt-Up Compound.
   b. SCA Construction Supply Div., Superior Concrete Accessories, Franklin Park, IL; Silcoseal 77.
   c. Burke Co., San Mateo, CA; Burke Clean Lift Bond Breaker or Burke Tilt Free Bond Breaker.

C. Patching Material: Contain no chlorides or other chemicals causing steel corrosion.

2.3 CONCRETE MIX DESIGN

A. Design: Select and proportion ingredients using trial batches; sample, cure and test concrete mix through an approved independent testing laboratory in accordance ACI 309-89 per ACI 211.1-91.

1. Concrete Compressive Strength, F'c:
   a. 4,000 psi at 28 days, unless otherwise shown (MAG Class AA except as modified in this Specification).
   b. 3,000 psi at 28 days, reinforced concrete cutoff wall.
   c. Design lab-cured trial mix cylinders.
   d. Use additional cement or cement plus fly ash above minimum specified if required to meet average compressive strength, F'cr.
   e. Use F'cr as basis for selection of concrete proportions as set forth in Chapter 5 of ACI 318-89 and commentary ACI 318R-89.
   f. F'cr: Equal to F'c plus 1,200 when data is not available to establish standard deviation.
2. Concrete Fill:
   a. Design for 2,500 psi at 28 days using 1-inch aggregate (MAG Class B), 4-inch maximum slump and 0.50 maximum water-cement ratio.
   b. Use water-reducing admixture.

B. Proportions:

1. Design mix to meet aesthetic and structural concrete requirements.
2. In accordance with ACI 211.1-89 including Appendix 5 for mass concrete, unless specified otherwise.
3. Water-cement ratio (or water-cement plus fly ash ratio) shall control amount of total water added to concrete as follows. Limit water-cement ratio to value specified for combined aggregate grading selected as follows:

Coarse Aggregate Size	W/C Ratio
3 inch	0.45
1-1/2 inch	0.45
1 inch	0.42
3/4 inch	0.40

4. Minimum Cement Content:
   a. 470 pounds per cubic yard for concrete with 3-inch maximum size aggregate.
   b. 517 pounds per cubic yard for concrete with 1-1/2-inch maximum size aggregate.
   c. 540 pounds per cubic yard for 1-inch maximum size aggregate.
   d. 564 pounds per cubic yard for 3/4-inch maximum size aggregate.
   e. Increase cement content as required to meet strength requirements and water-cement ratio.

C. Concrete Shrinkage: Design mix so shrinkage test is in accordance with ASTM C157-89, results at 28 days do not exceed 0.048 percent.

D. Admixtures:

1. Air Content: 4 percent plus or minus, 1-1/2 percent when tested in accordance with ASTM C231-91; 3-1/2 to 4-1/2 percent for mass concrete.
2. Water Reducers: Use in all concrete.
3. Superplasticizers: Use as required for placement and consolidation of concrete.
4. Fly Ash: Maximum 25 percent, minimum 15 percent of total weight of fly ash plus cement. Combine fly ash with cement at batch plant. Fly ash shall be used in all concrete for the dam foundations, slabs, piers, abutments, walls, pilasters, and aprons. Fly ash may be used in all other concrete.

E. Slump Range at Site:

1. Minimum: 4 inches with superplasticizers.
2. Maximum: 8 inches with superplasticizers.
3. Minimum: 2 inches without superplasticizers.

4. Maximum: 5 inches without superplasticizers.
5. Take design mix test cylinders from concrete with slump equal to that used on Project.
6. Design concrete mix with slump as required for placement on slopes as shown.
7. Adjust slump as necessary for temperature at time of placement of exposed aggregate.

F. Combined Aggregate Gradings:

1. Structures: 1-1/2-inch maximum grading, as shown in table.
2. Mass Concrete: 3-inch maximum size. Grading in accordance with ACI 211.1-91, Appendix 5 and ASTM C33-93.
3. Limit water-cement ratio to value specified for combined grading selected.
4. Grading Limits:

Sieve Sizes	Percentage Passing		
	1-1/2" Max.	**1" Max.**	**3/4" Max.**
2"	- 100	-	-
1-1/2"	95 - 100	- 100	-
1"	65 - 85	90 - 100	- 100
3/4"	55 - 75	70 - 90	92 - 100
1/2"	-	-	68 - 86
3/8"	40 - 55	45 - 65	57 - 74
No. 4	30 - 45	31 - 47	38 - 57
No. 8	23 - 38	23 - 40	28 - 46
No. 16	16 - 30	17 - 35	20 - 36
No. 30	10 - 20	10 - 23	14 - 25
No. 50	4 - 10	2 - 10	5 - 14
No. 100	0 - 3	0 - 3	0 - 5
No. 200	0 - 2	0 - 2	0 - 2

2.4 CONCRETE MIXING

A. General: In accordance with ACI 304R-89.

B. Concrete Mix Temperatures: As shown below for various stages of mixing and placing:

CONCRETE TEMPERATURES				
Ambient Air Temp.	Concrete Member Size, Minimum Dimension			
	<12"	12"-36"	36"-72"	>72"
Minimum concrete temperature as mixed for indicated air temperature:				
Above 30 deg. F	60 deg. F	55 deg. F	50 deg. F	45 deg. F
0-30 deg. F	65 deg. F	60 deg. F	55 deg. F	50 deg. F
Below 0 deg. F	70 deg. F	65 deg. F	60 deg. F	55 deg. F
Maximum allowable gradual temperature drop in first 24 hours after curing period and after end of protection:				
--	50 deg. F	40 deg. F	30 deg. F	20 deg. F

C. Truck Mixers:

1. Equip with electrically actuated counters to readily verify number of revolutions of drum or blades.
2. Counter:
   a. Resettable, recording type, mounted in driver's cab.
   b. Actuated at time of starting mixers at mixing speeds.
3. Truck mixer operation shall furnish a concrete batch as discharged that is homogeneous with respect to consistency, mix, and grading.
4. If slump tests taken at approximately 1/4 and 3/4 points of load during discharge give slumps differing by more than 2 inches when specified, slump is more than 4 inches, discontinue use of truck mixer unless causing condition is corrected and satisfactory performance is verified by additional slump tests.
5. Before attempting to reuse unit, check mechanical details of mixer, such as water measuring, and discharge apparatus, condition of blades, speed of rotation, general mechanical condition of unit, admixture dispensing equipment, and clearance of drum.
6. Do not use nonagitating or combination truck and trailer equipment for transporting ready-mixed concrete.
7. Concrete Volume in Truck:
   a. Limit to 63 percent of total volume capacity in accordance with ASTM C94-90 when truck mixed.
   b. Limit to 80 percent of total volume capacity when central mixed.
8. Mix each batch of concrete in truck mixer for minimum 70 revolutions of drum or blades at rate of rotation designated by equipment manufacturer.
9. Perform additional mixing, if required, at speed designated by equipment manufacturer as agitating speed.
10. Place materials, including mixing water, in mixer drum before actuating the revolution counter for determining number of mixing revolutions.

D. Aggregates: Thoroughly and uniformly wash before use.

E. Admixtures:

1. Air-Entraining Admixture: Add at plant through manufacturer-approved dispensing equipment.
2. Water Reducers: Add prior to addition of superplasticizer.
3. Superplasticizers and Air-Entraining Admixtures:
   a. Add at concrete plant only through equipment furnished or approved by admixture manufacturer.
   b. Accomplish variations in slump, working time, and air content for flowable mixes by increasing or reducing superplasticizer dose or air-entraining admixture dose at ready-mix plant only.
   c. Equipment shall provide for easy and quick visual verification of admixture amount used for each dose.
   d. Add discharge amount to each load of concrete into separate dispensing container, verify amount is correct, then add to concrete.
   e. Additional dosage of superplasticizer may be added in the field using manufacturer-approved dispensing when unexpected delays cause too great of a slump loss.

2.5 SOURCE QUALITY CONTROL

A. Cement: Test for total chloride content.

B. Fly Ash: Test in accordance with ASTM C311-90.

C. Batch Plant Inspection: RESIDENT ENGINEER shall have access to and have the right to inspect batch plants, cement mills, and supply facilities of Suppliers, manufacturers, and Subcontractors, providing products included in these Specifications.

1. Weighing Scales: Tested and certified within tolerances set forth in the National Bureau of Standards Handbook No. 44.
2. Batch Plant Equipment: Either semiautomatic or fully automatic in accordance with ASTM C94-90.

PART 3 EXECUTION

3.1 PLACING CONCRETE

A. Preparation: Meet requirements and recommendations of ACI 304R-89 and ACI 301-89, except as modified herein.

B. Inspection: Notify RESIDENT ENGINEER at least 1 full working day in advance before starting to place concrete.

C. Discharge Time:

1. As determined by set time, do not exceed 1-1/2 hours after adding cement to water unless special approved time delay admixtures are used. Coordinate information with admixture manufacturer and RESIDENT ENGINEER prior to placing concrete.

2. Adjust slump or air content at site by adding admixtures for particular load when approved by RESIDENT ENGINEER, then adjust plant dose rest of placement. Additional dosage at site shall be through an approved dispenser supplied by admixture manufacturer.
3. Maintain required slump throughout time of concrete placement and consolidation. Discontinue use of superplasticizer if it fails to maintain slump in required range for the length of time required. Redesign mix adjusting set control admixtures to maintain setting time in the range required.

D. Placement into Formwork:

1. Before depositing concrete, remove debris from space to be occupied by concrete.
2. Prior to placement of concrete, dampen fill under slabs on ground, dampen sand where vapor retarder is specified, and dampen wood forms.
3. Reinforcement: Secure in position before placing concrete.
4. Place concrete soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep, except for slabs. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
5. Use placement devices, for example, chutes, pouring spouts, and pumps.
6. Vertical Free Fall Drop to Final Placement: 5 feet in forms, 8-inch or less wide and 8 feet in forms wider than 8 inches, except as specified.
   a. Superplasticized Mixes: Up to 15 feet if slump is over 6 inches.
   b. For placements where drops are greater than specified, use placement device such that free fall below placement device conforms to required value.
   c. Free fall limit to prevent segregation caused by aggregates hitting reinforcing steel.
7. Do not use aluminum conveying devices.
8. Provide sufficient illumination for interior of forms so concrete at places of deposit are visible permitting confirmation of consolidation quality.
9. Joints in Footings and Slabs:
   a. Ensure space beneath plastic water stop completely fills with concrete.
   b. During concrete placement, make visual inspection of entire water stop area.
   c. Limit concrete placement to elevation of water stop in first pass, vibrate concrete under water stop, lift water stop to confirm full consolidation without voids, place remaining concrete to full height of slab.
   d. Apply procedure to full length of water stops.
10. If reinforcement is in direct sunlight or is more than 20 degrees F higher in temperature than concrete temperature before placement, wet reinforcement with water fog spray before placing concrete to cool reinforcement.

11. Round off top exposed edges of walls with a 1/4-inch radius steel edging tool.

E. Conveyor Belts and Chutes:

1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
2. Do not use chutes longer than 50 feet.
3. Minimum Slopes of Chutes: Angled to allow concrete to readily flow without segregation.
4. Conveyor Belts:
   a. Approved by RESIDENT ENGINEER.
   b. Wipe clean with device which does not allow mortar to adhere to belt.
   c. Cover conveyor belts and chutes.

F. Retempering: Not permitted for concrete where cement has partially hydrated.

G. Pumping of Concrete:

1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to assure completion of concrete placement without cold joints in case of a primary placing equipment breakdown.
2. Minimum Pump Hose (Conduit) Diameter: 4 inches.
3. Replace pumping equipment and hoses (conduits) that are not functioning properly.

H. Maximum Size of Concrete Placements:

1. Limit size of each placement to allow for strength gain and volume change due to shrinkage.
2. Locate expansion joints, control joints, and construction joints in dam foundations, piers, aprons, and abutments as shown. Intermediate construction joints may be provided upon approval of the RESIDENT ENGINEER.
3. In pump station and building, provide wall vertical construction joints as shown or at maximum spacing of 40 feet.
4. Consider beams, girders, brackets, column capitals, and haunches as part of floor or roof system and place monolithically with floor or roof system.

I. Minimum Time Between Adjacent Placements:

1. Construction Joints: 14 days.
2. Control Joints: 6 days.
3. Expansion Joints: 1 day.
4. At least 2 hours shall elapse after depositing concrete in long columns and walls thicker than 8 inches before depositing concrete in beams, girders, or slabs supported thereon.

5. For columns and walls, 10 feet in height or less, wait at least 45 minutes prior to depositing concrete in beams, girders, brackets, column capitals, or slabs supported thereon.

J. Removal of Water: Unless tremie method for placing concrete is specified, remove water from space to be occupied by concrete.

K. Consolidation and Visual Observation:

1. Consolidate concrete with internal vibrators with minimum frequency of 8,000 cycles per minute and amplitude required to consolidate concrete in section being placed.
2. Provide at least one standby vibrator in operable condition at placement site prior to placing concrete.
3. Consolidation Equipment and Methods: ACI 309R-87.
4. Provide sufficient windows in forms or limit form height to allow for concrete placement through windows and for visual observation of concrete.
5. Vibration consolidation shall not exceed a distance of 5 feet from point of placement.
6. Vibrate concrete in vicinity of joints to obtain impervious concrete there.

L. Hot Weather:

1. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 305R-89.
2. Placement frequency shall be such that lift lines will not be visible in architectural concrete finishes.
3. Maintain concrete temperature below 80 degrees F at time of placement. Ingredients may be cooled before mixing.
4. Make provisions for windbreaks, shading, fog spraying, sprinkling, ice, or wet cover, or other means to provide concrete with temperature specified.
5. Prevent differential temperature between reinforcing steel and concrete.
6. Evaporation Retardant: As specified in Section 03370, CONCRETE CURING.

M. Cold Weather:

1. Maintain surface temperature of concrete above 40 degrees F and cure concrete as specified in Section 03370, CONCRETE CURING, for minimum of 10 days.
2. Provide maximum and minimum thermometers placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work.
3. In accordance with ACI 306R-88 and ACI 318-89.
4. External Heating Units:
   a. Vent heating units to atmosphere, and do not locally heat or dry concrete. Where water cure is specified, maintain wet condition.

b. Do not exhaust flue gases directly into an enclosed area to prevent concentrated carbon dioxide from causing concrete carbonation.

5. Maintain curing conditions as specified in Section 03370, CONCRETE CURING.

3.2 CONCRETE BONDING

A. To New Concrete Wall Horizontal Construction Joints:

1. Thoroughly clean and saturate joint with water.
2. Limit concrete lift placed immediately above construction joint to 12 inches thick.
3. Thoroughly vibrate.

B. To Old Concrete, Roller Compacted Concrete, and CSA:

1. Mechanically roughen existing concrete surfaces to a clean, rough surface using a "Blastrac" by Wheelabrator-Frye, Inc.; or "Porta-Shotblast" by Nelco Manufacturing Corp, or as approved by the RESIDENT ENGINEER to remove existing concrete surface, and provide a minimum roughness profile of 1/4-inch.
2. Saturate surface with water for 24 hours.

3.3 CONSTRUCTION JOINTS

A. As specified in Section 03251, EXPANSION, CONSTRUCTION, AND CONTROL JOINTS.

3.4 PATCHING

A. General:

1. Repair of surface defects and tie holes shall be performed on the mock-up panels to allow color and texture match of the repair to the finished surface specified.
2. Leak lines shall be removed by pneumatic-type needle guns.
3. Prior to starting patching work, obtain quantities of color-matched patching material and manufacturer's detailed instructions for use to provide a structural patch with finish to match adjacent surface.
4. Develop patching techniques with grout manufacturer on mockup panel.
5. Dress surface of patches that will remain exposed to view to match color and texture of adjacent surfaces. Patching of concrete shall provide a structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to RESIDENT ENGINEER.
6. Very lightly sandblast repairs where, in the opinion of RESIDENT ENGINEER, total uniformity in the surface is required.

B. Tie Holes:

1. Fill with Category I or II grout as specified in Section 03600, GROUT, except where sealant is shown. Use only enough water to dry pack.
2. Match color of adjacent concrete.
3. Compact grout using steel hammer and steel tool to drive grout to high density. Cure grout with water.

C. Alternate Form Ties—Through-Bolts:

1. Seal through-bolt hole by sandblasting or mechanically cleaning and roughening entire interior surface of hole, epoxy coating roughened surface and driving elastic vinyl plug and then dry packing entire hole on each side of plug with Category II grout, as specified in Section 03600, GROUT. Use only enough water to dry pack grout. Dry pack while epoxy is still tacky or remove epoxy by mechanical means and reapply new epoxy.
2. Fill through-bolt openings with Category II grout, as specified in Section 03600, GROUT.
3. Compact grout using steel hammer and steel tool to drive grout to high density. Cure grout with water.

D. *Defective* Areas:

1. Remove *defective* concrete to a depth of sound concrete.
2. Small shallow holes caused by air entrapment at surface of forms shall not be considered *defective* unless amount is so great as to be considered not the standard of the industry.
3. If chipping is required, make edges perpendicular to surface with a minimum of 1/2 inch in depth. Do not feather edges. Obtain RESIDENT ENGINEER's approval of chipping work.
4. Patch *defective* area to match appearance of adjacent concrete surfaces after cracks are filled.

E. Blockouts at Pipes or Other Penetrations:

1. Meet details shown or submit proposed blockouts for review.
2. Use nonshrink, nonmetallic grout, Category I or II.

3.5 CONCRETE WALL FINISHES

A. Ordinary Wall Finish:

1. Use where below grade or not exposed to view.
2. Patch tie holes.
3. Knock off projections.
4. Patch *defective* areas.

B. Smooth Wall Finish:

1. Use on all walls unless otherwise shown.
2. Patch tie holes.

3. Grind off projections, fins, and rough spots.
4. Patch *defective* areas and repair rough spots resulting from form release agent failure or other reasons to provide smooth uniform appearance.

C. Sandblast Finish:

1. Prepare wall as required for smooth wall finish.
2. Sandblast where noted on Drawings in accordance with ACI Manual of Concrete Practice, 1993, 303R-25:
   a. Light Sandblast: Intent of this procedure is to remove surface skin to a depth no more than 1/16 inch, and expose only fine aggregate and air holes near the surface, thus producing a uniform texture.
   b. Medium Sandblast: Intent of this procedure is to remove the surface skin to a depth of no more than 1/4 inch, sufficient to generally expose coarse aggregate with only a slight reveal, producing a uniform texture.
3. Perform sandblasting on concrete surfaces in the same area of view all at the same time and obtain uniformity of appearance.
4. Perform sandblasting on concrete surfaces that are approximately of the same age. Age of sample panel, concrete placement, and removal of forms at time of sandblasting shall be same as anticipated for actual field concrete.
5. The same person shall accomplish sandblasting on one structure and on concrete in the same area.
6. Perform sandblasting to match approved mockup panel.
7. Abrasive: Use clean silica sand free of foreign materials and supplied in sealed sacks.
8. Blast surface with 100 psi air pressure at rate of 2 to 3 square feet per minute with nozzle held approximately 2 feet from surface and perpendicular thereto.

3.6 CONCRETE SLAB FINISHES

A. General:

1. Do not use "jitterbugs" or other special tools designed for the purpose of forcing coarse aggregate away from the surface and allowing a layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
2. Do not dust surfaces with dry materials.
3. Use evaporation retardant.
4. Round off edges of slabs with a steel edging tool, except where a cove finish is shown. Steel edging tool radius shall be 1/4 inch.

B. Steel Troweled Finish:

1. Use on all slabs unless otherwise shown.
2. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation. Use evaporation retardant.

3. While concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, wood float to true, even plane with no coarse aggregate visible.
4. Use sufficient pressure on wood floats to bring moisture to surface.
5. After surface moisture has disappeared, hand trowel concrete to produce smooth, impervious surface, free from trowel marks.
6. Burnish surface with an additional troweling. Final troweling shall produce a ringing sound from trowel.
7. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.
8. Power Finishing:
   a. An approved power machine may be used in lieu of hand finishing in accordance with directions of machine manufacturer.
   b. Do not use power machine when concrete has not attained the necessary set to allow finishing without introducing high and low spots in slab.
   c. Do first steel troweling for slab finish by hand.

C. Underside Elevated Slab Finish: When forming is removed, grind off projections on underside of slab and patch *defective* areas, including small shallow air pockets where schedule of concrete finishes requires:

D. Light Broomed Finish: Finish as specified for steel troweled floor finish, except omit final troweling and finish surface by drawing a fine-hair broom lightly across the surface.

1. Brooming: In same direction and parallel to expansion joints, or, in the case of inclined slabs or surfaces, perpendicular to slope.

E. Heavy Broomed Finish: Same as light broomed finish, except use a coarse stiff bristle broom.

F. Sidewalk Finish:

1. Slope walks down 1/4 inch per foot away from structures, unless otherwise shown.
2. Strike off surface by means of strike board and float with wood or cork float to a true plane, then flat steel trowel before brooming.
3. Broom surface at right angles to direction of traffic or as shown.
4. Lay out sidewalk surfaces in blocks, as shown or as directed by RESIDENT ENGINEER, with a grooving tool.

G. Exposed Aggregate Finish:

1. Prepare and cast a 3-foot 0-inch square test panel at the same time as the job is cast as a means of determining the proper time for aggregate exposure.
2. Immediately after the base slab has been placed, screeded, and floated, seed a single layer of the selected aggregate over the surface. Remove any stacked or flat, slivery particles.
3. Embed aggregates by tamping with wood float, darby, or rolling device.
4. Float concrete to cover seeded aggregate with a thin layer of mortar.

5. Spray surfaces with retardar following float finish and cure as specified in Section 03370, CONCRETE CURING.

H. Concrete Curbs:

1. Float top surface of curb smooth, and finish all discontinuous edges with steel edger.
2. After concrete has taken its initial set, remove front form and give exposed vertical surface an ordinary wall finish.

3.7 BEAM, PILASTER, AND COLUMN FINISHES

A. General: Patch and repair *defective* areas.

B. Beam:

1. Repair rock pockets.
2. Fill air voids.
3. Match smooth wall finish.

C. Pilasters and Columns:

1. Fill air pockets.
2. Match sandblast wall finish.

3.8 BACKFILL AGAINST WALLS

A. Do not backfill against walls until concrete has obtained 28-day compressive strength.

B. Place backfill simultaneously on both sides of wall, where required, to prevent differential pressures.

3.9 FIELD QUALITY CONTROL

A. General:

1. Provide adequate facilities for safe storage and proper curing of concrete test cylinders onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
2. Provide concrete for testing of slump, air content, and for making cylinders from the point of discharge into forms. When concrete is pumped, Samples used shall be taken from discharge end of pump hose.
3. Evaluation will be in accordance the MAG Specifications Section 725.10 and 725.11 an these Specifications.
4. Specimens will be made, cured, and tested in accordance with ASTM C31-90a and ASTM C39-86.
5. Frequency of testing may be changed at discretion of RESIDENT ENGINEER.
6. Pumped Concrete: Take concrete samples for slump (ASTM C143-90a) and test cylinders (ASTM C31-90a and C39-86)

and shrinkage specimens (ASTM C157-89) at placement (discharge) end of line.

B. Admixture Segregation Test: Test each truck prior to use on job.

1. Segregation Test Objective: Concrete with 5- to 9-inch slump must stay together when slumped. Segregation is assumed to cause mortar to flow out of mix even though aggregate may stay piled enough to meet slump test.
2. Test Procedure: Make slump test and check for excessive slump and observe to see if mortar or moisture flows from slumped concrete.
3. Reject concrete if mortar or moisture separates and flows out of mix.

C. Tolerances:

1. Walls: Measure and inspect walls for compliance with tolerances specified in Section 03100, CONCRETE FORMWORK.
2. Slab Finish Tolerances and Slope Tolerances:
   a. Slab flatness measurements will be made the day after floor is finished and before shoring is removed, to eliminate effects of shrinkage, curing, and deflection.
   b. Support 10-foot long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
   c. Compliance with designated limits in four of five consecutive measurements is satisfactory unless *defective* conditions are observed.

3.10 MANUFACTURER'S SERVICES

A. Provide the following representative at site in accordance with Section 01640, MANUFACTURERS' SERVICES, for installation assistance, inspection and certification of proper installation for concrete ingredients, mix design, mixing, and placement.

1. Batch Plant Representative:
   a. Observe how concrete mixes are performing.
   b. Be present during first placement of each type of concrete mix.
   c. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout the Project.
   d. Establish control limits on concrete mix designs.
2. Admixture Manufacturer's Representative:
   a. Demonstrate special features, product performance, product mixing, testing, and placement or installation for each type of admixture.
   b. Observe how concrete mixes are performing.
   c. Be present during the first placement of each type of concrete mix.
   d. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout the Project, including instructions for redosing.

3.6 SHOTCRETE PLACEMENT

A. General:

1. Apply shotcrete in accordance with ACI 506.2-90.
2. Apply shotcrete utilizing wet mix process.
3. Increase cement content if shotcrete fails to meet 28-day strength of at least 4,000 psi.
4. If flow of shotcrete becomes intermittent, direct away from Work until flow becomes constant.
5. Apply shotcrete at total thickness of 8 inches minimum.

B. Rebound Removal:

1. Use 3/4-inch blowpipe to remove rebound, sand, and miscellaneous debris ahead of shotcrete work.
2. Protect adjacent concrete, other surfaces, and equipment from being damaged by overshooting shotcrete. Remove overshot shotcrete and deposited rebound materials as Work proceeds.
3. Do not work rebound into shotcrete.

C. Nozzle Position:

1. Keep nozzle at uniform constant distance from surface, always ensuring a right-angle spray of material to surface.
2. Modify procedure of shooting shotcrete to better direct material around reinforcing bars.
3. Apply shotcrete material wet enough to ensure no buildup of shotcrete to prevent voids.

D. Shotcreting More than One Layer:

1. Allow each layer of shotcrete to set before applying next layer without sagging.
2. Steel broom shotcrete layers after initial set to increase bond of next shotcrete coat.
3. Do not broom shotcrete surfaces before shotcrete has initially set.
4. Dry sandblast with silica sand, surfaces that have not been broomed.
5. Before applying next layer of shotcrete, sound surface with hammer for hollow areas.
6. Remove and replace hollow areas before applying next layer of shotcrete.
7. Remove rebound pockets before next layer is applied. Corner areas are particularly susceptible to this condition.
8. Slope construction or work joints to a thin, clean, regular feathered edge.

E. Finish:

1. Slab tolerances shall be as specified in Section 03100, CONCRETE FORMWORK.
2. Finish shotcrete as shown and as specified in Section 03300, CAST-IN-PLACE CONCRETE.

3. On completing surface, bring shotcrete to an even plane and to well-formed corners by working up to ground wires or other thickness or alignment guides, using lower placing velocity than normal.
4. Screed exposed surfaces or underlayers by working upward against gravity with thin-edged screed using a slicing motion to trim off high spots and expose low spots.
5. Avoid pulling and breaking surface with subsequent checking.

3.7 WATER CURING

A. Wet cure shotcrete as specified in Section 03370, CONCRETE CURING, for a period of 10 days.

B. Curing shall not cause erosion of shotcrete.

C. Do not membrane cure shotcrete.

D. Intermediate Layers of Shotcrete:

1. Keep damp by hand curing or other means.
2. Water curing is not required if next layer of shotcrete is applied within 12 hours of previous layer.
3. Avoid indiscriminate use of continuous water curing, causing excessive deposits of free alkali on surface preventing bonding between layers.

3.8 FIELD QUALITY CONTROL

A. Wet Mix Process: Take shotcrete cylinders from mixer or ready-mix truck and test as specified in Section 03300, CAST-IN-PLACE CONCRETE.

B. Shotcrete evaluation will be based on results obtained from cylinders and drilled cores in accordance with ASTM C1140 and the MAG Specifications Section 725.10 and 725.11. Not less than four core cylinder specimens shall be taken and tested at 28 days for each 100 cubic yards of concrete.

C. Use of data obtained from impact hammers, ultrasonic equipment, or nondestructive testing devices is not permitted. However, these devices may be used for determining uniformity of shotcrete.

D. Remove and replace shotcrete found not meeting tests, or cut cores and further test shotcrete, or repair and replace as approved by RESIDENT ENGINEER.

3.9 MANUFACTURER'S FIELD SERVICE

A. Provide the services of a qualified technical representative of manufacturer of polypropylene fibers to instruct the concrete supplier in proper batching and mixing of materials to be provided.

END OF SECTION

SECTION 03365
ROLLER-COMPACTED CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work necessary to furnish, install, and complete the roller-compacted concrete (RCC), including all plant materials, equipment, and labor to produce the RCC, bedding concrete, and bedding mortar.

1.2 TESTING

A. Except as otherwise specified, all testing and mix designs and testing during construction shall be performed by CONTRACTOR's Testing Laboratory. DESIGN ENGINEER will review the test results. CONTRACTOR shall pay all costs associated with the services of the testing laboratory.

B. Except as otherwise allowed, specified, or supplemented by this section, RCC shall be subject to Section 03300, CAST-IN-PLACE CONCRETE.

1.3 REFERENCES

A. CONTRACTOR shall have available in the field office a copy of the applicable portions of the following publications:

1. U.S. Army Corps of Engineers Handbook for Cement and Construction CRD.
2. American Society for Testing and Materials (ASTM) Annual Book of Standards:
   a. Section 4, Volume 04.02, Concrete and Aggregate.
   b. Section 8, Volume 04.08, Soil and Rock: Dimension stone; geosynthetics.
3. Roller Compacted Concrete Dams, Hansen, K.D., and Reinhardt, W.G., McGraw Hill, 1991.

1.4 SUBMITTALS

A. Submittals shall be made in accordance with Section 01300, SUBMITTALS.

1. Mix Designs: CONTRACTOR shall submit the mix designs performed by CONTRACTOR's Testing Laboratory experienced in RCC mix design. Mix designs shall be stamped by a registered civil engineer in the State of Arizona. Mix designs shall conform to these Specifications for RCC, bedding concrete, and bedding mortar.
2. Test results, materials certification, quality control records, and other submittals as specified herein.

1.5 TEST SECTION

A. A test section of RCC shall be constructed by CONTRACTOR at a location determined by DESIGN ENGINEER. The location will be suitable for

demonstrating bedding, and RCC placement. CONTRACTOR shall demonstrate the quality, efficiency, and workability of all the materials and equipment necessary for uninterrupted production and construction of the dam foundation in conformance with these Specifications. CONTRACTOR shall use personnel on the test section who will be working directly on, or directly supervising work on, the dam in order to familiarize personnel with the process and products. The test section shall be completed a minimum of 14 days prior to placement of RCC in the downstream dam foundation.

B. The RCC test section shall be a minimum of three lifts, each 12 inches high, and shall be 20 feet (base width) by 80 feet long.

C. Test Section Placement:

1. CONTRACTOR shall grade and prepare the test section site to provide an adequate foundation similar to the foundation adjacent to the grade control structure. The foundation preparation, bedding concrete, RCC, and bedding mortar shall be placed with the methods and in the sequence that will occur during actual construction and as specified herein. Placement of layers and materials shall conform to the sequence of this Specification and as proposed for the dam and approved by DESIGN ENGINEER.
2. The initial lift on the foundation on top of the drain gravel shall be with 3-inch thick layer of bedding concrete followed immediately with RCC.
3. RCC lifts shall be placed to obtain a 12-inch compacted lift thickness. The RCC shall be compacted by eight passes of the roller. CONTRACTOR shall roll out to the limits of the RCC edge.
4. The remaining lifts shall be placed in the same manner as the first, except the roller shall make six passes on the fourth lift and higher.
5. The first four lifts shall be greater than 8 hours old, followed by the required cleanup, placing of bedding mortar, before placing the next lifts of RCC.

D. Testing:

1. The Independent Testing Laboratory shall test the density and moisture content of the RCC mix as specified for dam foundation placement, except that the in-place density shall be checked in the same location after each roller pass in order to establish a relationship between number of roller passes and in-place density. A minimum of four locations shall be tested in each lift. Each quadrant shall be tested at each location.
2. The Independent Testing Laboratory shall conduct mixer performance testing as specified hereinafter.

E. On the 10th day following placement of the test section, CONTRACTOR shall cut the test section to a depth of 36 inches across the width of the test section in two locations and remove adjacent material to expose the face of the cut. The purpose of these cuts is to allow visual inspection of the full RCC/bedding cross section.

F. On the 14th day following placement of the test section, CONTRACTOR shall extract and prepare cores from the test section in accordance with ASTM C42. The equipment used for drilling cores shall include a diamond drill and a double-tube type core barrel capable of obtaining a minimum length of 48 inches of RCC. Locations of drill holes will be selected by DESIGN ENGINEER. Drill holes shall be vertical. CONTRACTOR shall be required to extract up to 12 feet of drilled core. Core samples shall be cut by CONTRACTOR in accordance with ASTM C42 and as directed by DESIGN ENGINEER. The Independent Testing Laboratory shall conduct compression tests and density tests on a minimum of four core samples at 14 days and 28 days after placement of the test section.

G. Upon satisfactory completion of the test section based on observation and density testing during construction of the test section, approval will be given to CONTRACTOR to proceed with RCC placement for the dam foundation adjacent to the grade control structure.

H. Within 14 days after completion of the test section, DESIGN ENGINEER will notify CONTRACTOR of RCC placement requirements for the dam, i.e., roller acceptability, number of passes required, maximum density, acceptable mix designs for the dam, and applicable criteria.

I. Roller-compacted concrete within the test section that does not meet the minimum requirements of these Specifications, as determined by DESIGN ENGINEER, shall require placing additional lifts to the test section at the expense of CONTRACTOR. No payment will be made for additional placement of RCC.

PART 2 PRODUCTS

2.1 GENERAL

A. RCC, bedding concrete, and bedding mortar shall be composed of portland cement, pozzolan, admixtures, aggregates, and water.

2.2 CEMENT AND POZZOLAN

A. General: Cement and pozzolan shall be furnished in bulk except that cement for finishing and patching may be packaged. The source of cement and pozzolan shall consistently supply material with similar chemical and physical properties. The sources of cement and pozzolan shall not be changed from those submitted at the time of the initial mix design without written approval by DESIGN ENGINEER.

B. Portland Cement: Portland cement shall be Type II cement and shall meet the requirements of ASTM C150. Maximum alkalies shall be 0.60 percent.

C. Pozzolan: Pozzolan shall conform to ASTM C618, Class F except as modified herein:

1. Fly ash shall meet Table 2, Supplemental Optional Chemical Requirements, and Table 4, Supplemental Optional Physical

Requirements of ASTM C618. Mortar expansion test shall be made with the cement used in the work.

2. Loss on Ignition: Maximum 3 percent.
3. Water Requirement: Maximum 100 percent of control.
4. $\frac{CaO(\%)-5}{Fe_2O_3(\%)}$: Maximum 1.5

D. Cement Sources: Each shipment of cement shall be accompanied by a certified delivery slip or mill certificate of compliance showing results of physical and chemical tests along with Specification requirements. No cement shall be used until written notice has been given by DESIGN ENGINEER that test results are satisfactory. In the event of failure, the cement may be resampled and tested at the request of CONTRACTOR and at CONTRACTOR's expense.

E. Pozzolan Source: Each shipment of pozzolan shall be accompanied by a certified delivery slip or mill certificate of compliance showing results of physical and chemical tests along with Specification requirements. No pozzolan shall be used until written notice has been given by DESIGN ENGINEER that test results are satisfactory.

F. Transportation of Bulk Cement and Pozzolan: When bulk cement and pozzolan is not unloaded from primary carriers directly into weathertight storage silos at the concrete plant, transportation from the railhead, mill, or intermediate storage to the batching plant shall be accomplished in adequately designed weathertight trucks, conveyors, or other means which will completely and thoroughly protect the cement and pozzolan from exposure to moisture.

G. Temperature of Cement and Pozzolan: The temperature of cement and pozzolan when delivered to the jobsite shall not exceed 150 degrees F. The temperature of air (if that process is used) to transport cement into storage containers or silos shall not exceed 150 degrees F. The temperature of the air will be determined by measuring the temperature on the outside of the transport pipe with a surface thermometer.

H. Storage: Immediately upon receipt at the concrete plant, cement and pozzolan shall be stored in a dry, weathertight, and properly ventilated structure. All storage facilities shall be subject to approval and shall be such as to permit easy access for inspection and identification. Sufficient cement and pozzolan shall be in storage to complete at least two shifts of placement at the typical production rate being experienced. In order that cement and pozzolan may not become unduly aged after delivery, CONTRACTOR shall use any cement that has been stored at the site for 60 days or more before using cement and pozzolan of lesser age.

2.3 ADMIXTURES

A. Air entraining admixtures, superplasticizers, water reducers, and retarders shall conform to Section 03300, CAST-IN-PLACE CONCRETE. The admixture for RCC shall be PDA-50 manufactured by Conchem.

2.4 WATER

A. Water for washing or spraying aggregates and for mixing and curing concrete shall be clean potable water containing less than 500 ppm of chlorides.

2.5 RCC AGGREGATE

A. Aggregate for RCC shall be produced and stockpiled as specified in Section 02205, EXCAVATION. RCC aggregate from these stockpiles shall be processed and blended together to meet the following gradation requirements.

Sieve Size	Percent Fines by Weight
2-inch	100
1-1/2-inch	90-100
3/4-inch	75-90
3/8-inch	55-70
No. 4	35-47
No. 16	17-35
No. 50	12-25
No. 200	0-10

2.6 MIX TYPES

A. RCC mixes shall be designed and paid for by CONTRACTOR. These will consist of the RCC mix, bedding concrete, and bedding mortar. Submit a mix design report prepared under the supervision of and sealed by a professional engineer licensed in the State of Arizona, with at least 5 years of experience in RCC design and construction. The mix design report shall show the results of various tests at varying proportions of the above materials so as to identify an appropriate mix. Mix designs may be changed by DESIGN ENGINEER during construction.

2.7 RCC MIX DESIGN

A. RCC: Mix design of RCC shall be performed by CONTRACTOR. Roller-compacted concrete shall consist of a mixture of fine and coarse aggregate, pozzolan, and cement that is combined with water to a damp consistency that can be transported by conveyor, spread and compacted in level horizontal layers, and cured.

B. Mix Parameters: The following are general ranges of parameters CONTRACTOR shall start with for designing the RCC mix:

Cement content	150 to 300 lb/cy
Pozzolan content	100 to 150 lb/cy
Retarder, PDA-50	10 to 15 oz/cy
Water content	170 to 200 lb/cy
Compressive strength at 28 days	1,800 psi, minimum

2.8 BEDDING MORTAR MIX DESIGN

A. Mix design and testing of the bedding mortar shall be performed by CONTRACTOR. Bedding mortar shall consist of a broomable high portland cement/pozzolan content sand mortar applied to the surface of the existing CSA at the abutments and to the top of wall lifts of RCC. Aggregate shall be produced from stockpiles of onsite processed material or imported material at CONTRACTOR's option.

B. Mix Parameters:

Slump	6 to 9 inches
Maximum aggregate size	No. 4
Air content	5 to 7 percent
Water-reducer	5 oz/cy
Retarder	5 oz/cy
Cement content	500 lb/cy, minimum
Pozzolan content	100 lb/cy, minimum
Compressive strength at 28 days	1,800 psi, minimum

2.9 BEDDING CONCRETE MIX DESIGN

A. Bedding concrete shall consist of a high slump concrete conforming to the gradation for RCC. With a higher cement and pozzolan content, the bedding concrete will be used at the interface between the drain gravel foundation and RCC and where the RCC contacts the abutments as shown.

B. Mix Parameters:

Slump	5 to 8 inches
Maximum aggregate size	2-inch
Gradation	Conform to RCC
Air content	4 to 6 percent
Water-reducer	5 oz/cy

Retarder	5 oz/cy
Cement content	250 to 350 lb/cy
Pozzolan content	150 to 250 lb/cy
Compressive strength at 28 days	1,800 psi, minimum

2.10 MIXING AND PROPORTIONING

A. General:

1. The RCC plant shall be a continuous mix or batch-type pugmill. CONTRACTOR shall select the type of concrete plant for RCC production to be used and shall determine its layout. The layout shall conform to that submitted in the Construction Plan unless otherwise approved by DESIGN ENGINEER. CONTRACTOR shall have the concrete plant onsite, in-place, and in operating condition at least 3 days prior to the start of production of RCC mixing and placing RCC in the test section. Plant shall be designed specifically for operation with the no slump aggregate RCC mix specified.
2. The RCC plant shall conform to the guidelines and requirements of ASTM C685, except as otherwise specified. Proportioning tolerances shall be as specified herein. The continuous mix plant shall be an ARAN ASR-250E or equivalent. The batch-type plant shall be a Ross Combimix Twin Shaft Compulsory Mixer or equivalent.
3. The RCC plant control system shall have the capability of changing mix designs instantaneously, producing at least four different RCC mix designs, and producing any of the mix designs at a variable production rate.
4. The mixing plant shall have a rated capacity of at least 200 cubic yards per hour. Conveying, placing, compacting, and cleanup systems shall be designed to match a minimum 100-cubic yard per hour rate of compacted RCC production and placement. If an accelerated schedule or increased production rate is planned by CONTRACTOR such that the specified concrete plant is not capable of producing mixes of the required quality fast enough, additional equipment shall be provided.
5. Plant Demonstration: The capability to produce and place RCC meeting all production requirements and uniformity requirements at an 80-cubic yard per hour rate for 3 consecutive hours shall be demonstrated during the construction of the test section. If the RCC production requirements and uniformity requirements are not demonstrated, immediate actions shall be taken to either increase the capacity of the mixing operations, make adjustments to increase production and uniformity, or replace the operation to meet job production rate Specifications. The above required demonstration shall be repeated until the capability to meet job Specifications is established. Material not meeting these Specifications will be rejected.
6. The mixers shall be maintained in satisfactory operating condition, and shaft and paddles shall be kept clean of hardened concrete. Mixer paddles shall be replaced when worn down more than 20 percent of

their original surface area. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired. CONTRACTOR shall be responsible to perform, at his expense, all necessary shakedown and trial runs of his mixing and proportioning equipment, and the mixer performance test as described hereafter in this section, so that when it is put into production operation for construction of the test section and the dam, it consistently and accurately provides mixes of the quality required by these Specifications.

7. Material not meeting these Specifications will be rejected and not allowed in the test section or the dam. If it has been placed, but should have been rejected, DESIGN ENGINEER will require its removal from the structure at CONTRACTOR's expense. CONTRACTOR shall permit access by DESIGN ENGINEER, RESIDENT ENGINEER, and the Independent Testing Laboratory at every time to the plant and related equipment. CONTRACTOR shall notify DESIGN ENGINEER before mixing concrete. CONTRACTOR shall provide equipment and shall maintain and operate the equipment as necessary to accurately determine and control the prescribed amounts of the various materials entering the concrete mixers.
8. Design of the RCC plant shall include a redundant safety system to ensure complete shutdown of the plant during all cleaning and maintenance.
9. Delivery of materials from the plant dispensing system to the mixer shall be within the following limits of accuracy:

Material	Percent
Cement and Pozzolan	+2
Water	+2
Aggregate	±2
Admixture	±3

B. Bins and Silos: Separate bins or compartments shall be provided for each size group of aggregate. Separate silos shall be provided for bulk portland cement and for pozzolan. The silos and compartments shall be of ample size and so constructed that the various materials will be maintained separated under all working conditions. All compartments containing cement and pozzolan shall be separated from each other by a free-draining air space. The bins shall have steep sideslopes, large gate openings, and be capable of handling the aggregate in a damp condition without choking.

C. Batch Type Plant:

1. Weigh Batchers: Aggregates shall be weighed in separate weigh batchers with individual scales. Bulk cement and pozzolan shall each be weighed on a separate scale in a separate weigh batcher. If the batch plant is equipped with automatic interlocking sequential batching controls, the cement and pozzolan may be weighed cumulatively with

one scale and hopper so long as weighing is automatically controlled within the specified tolerances and cement is weighed first.

2. Water Batcher: A suitable water measuring device shall be provided which will be capable of measuring the mixing water within the specified requirements for each batch. The mechanism for delivering water to the mixers shall be free from leakage. The filling and discharge valves for the water batcher shall be interlocked so that the discharge valve cannot be opened before the filling valve is fully closed. When a watermeter is used, a suitable strainer shall be provided ahead of the metering device. The water batcher shall be calibrated so that the indicated volume of water provides the equivalent corresponding weight of water. Fifty-five-gallon drums may be used for water batcher calibration.
3. Moisture Control: The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to adjust the mix proportions.
4. Admixture Dispensers: A separate batcher or dispenser shall be provided for each admixture. Volumetric dispensers shall be used only for liquid admixture, and each plant shall be equipped with the necessary calibrated devices that will permit convenient checking of the accuracy of the dispensed volume of the particular admixture. The batching or dispensing devices shall be capable of repetitively controlling the batching of the admixtures to the accuracy specified. Piping for liquid admixtures shall be free from leaks, and properly valved to prevent backflow or siphoning. The dispensing system shall include a device or devices which shall either detect and indicate the presence or absence of flow of the admixture, detect and indicate the presence or absence of the admixture, or provide a convenient means of visually observing the admixture in process of being batched or discharged. Each system shall be capable of ready adjustment to permit varying the quantity of admixture to be batched. Each dispenser shall be interlocked with the batching and discharge operations so that each admixture is added separately to the batch in solution in a separate portion of the mixing water or of the fine aggregate in a manner to ensure uniform distribution of the admixtures throughout the batch during the required mixing period.
5. Scales and Records: Adequate fully automatic or semiautomatic facilities shall be provided for the accurate measurement and control of each of the materials entering each batch of concrete. The weighing equipment shall conform to the applicable requirements of NBS Handbook 44 except that the accuracy can vary by up to 0.2 percent of scale capacity. CONTRACTOR shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring device. Each weighing unit shall be provided with a digital readout located within the plant control house capable of showing all scale weights and providing a printout of each batch showing the time of batching, mix time, and total weight of each ingredient entering the mixer. The weighing equipment shall be arranged so that the plant operator can conveniently observe all dials and indicators.
6. Batching Operation: The measuring operation of each material shall start when actuated by one or more starting mechanisms and stop automatically when the designated weight or volume of each material

has been reached. They shall be interlocked in such a manner that the discharge device cannot be actuated until the indicated quantity of material is within the applicable tolerance. These control requirements can be satisfied by a semiautomatic batching system as defined in the CPMB Concrete Plant Standards, with interlocks as described above, or by an automatic batching system as defined in the Concrete Plant Standards. The plant shall be arranged so as to facilitate the inspection of all operations at all times.

D. Continuous Mix Plants:

1. Cement and Aggregate Feed: Aggregate feed may be accomplished onto a single belt from feed bins for the various size groups through openings at the bottom of the bins. Each opening shall be provided with a gate that can be locked at the necessary opening size to provide the correct feed rate. The bins shall be kept sufficiently full and shall be of sufficient size to ensure a uniform flow of aggregate at an essentially constant rate. Cement and pozzolan shall be fed continuously by belt, vane, or auger feed. The feed shall be capable of gradual adjustment while in operation. Continuously correcting automated gate openings and/or belt-feed rates controlled electronically by feedback of weight sensor units on the belts shall be used if operation without them is not capable of providing the accuracy, consistency, and good quality required by these Specifications.
2. Water Dispenser: A suitable water dispenser shall be provided which will be capable of dispensing the mix water within the specified requirements. The mechanism for delivering water to the mixers shall be free from leakage. The meter may be an in-line volumetrically activated flowmeter, but it shall be adapted to read the weight of water being added in pounds per minute. The valve shall be capable of gradual adjustment during the mixing process to compensate for varying moisture contents in the aggregates. The valve shall be automatically controlled so that it will close if cement and/or aggregate stops entering the mixer at the required rate.
3. Operation: The mixers shall have proper introduction of ingredients as specified by manufacturer and shall not be charged in excess of the capacity recommended by the manufacturer. Mixers shall be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. The mixers shall be operated at the speed designated by the manufacturer and shall be capable of changing retention time of the ingredients in the mixer. If a uniform mix of the required proportions is not being discharged from the mixer at that time, the material shall continue to be wasted until consistent material of the specified proportions is discharged.
4. Records: Accurate continuous records of the feed rates of each material shall be made in a manner and format acceptable to DESIGN ENGINEER. Totals of cubic yards produced and the amount of each material used shall be given to RESIDENT ENGINEER at the end of each shift.

E. Mixer Trial Run: Suitable facilities shall be provided for obtaining representative samples of concrete for mixer performance testing. All

necessary platforms shelters, tools, and equipment shall be provided for obtaining samples. For the initial trial runs, after the plant has been calibrated for all the ingredients, trial runs of at least 5 minutes' duration will be performed. Trial runs shall be performed at a minimum rate of 80 compacted cubic yards/hour with test samples obtained during the last of the trial run. The initial trial run mixed materials shall be wasted.

2.11 MIXER PERFORMANCE

A. General: The RCC plant and delivery system shall combine the materials into a uniform mixture that meets the uniformity requirements of mixer performance testing.

B. Mixers shall not be charged in excess of the capacity recommended by the manufacturer. Mixing time for each batch, after all materials are in the mixer, shall be a minimum of 60 seconds for mixers having a capacity of 3 cubic yards. For mixers of larger capacity, the mixing time shall be increased by 15 seconds for each additional cubic yard or fraction thereof. The mixing time shall be increased when such increase is necessary to secure the specified uniformity requirements. Measurement of mixing time for continuous mixers shall equal the equivalent ingredient retention time in the mixer in cubic yards per minute.

C. When CONTRACTOR proposes to reduce the mixing time, mixer performance tests at the reduced mixing time shall be made to determine whether the reduced mixing time will produce RCC that meets the uniformity requirements. If results of the mixer performance test indicate adequate mixing at the reduced mixing time, the mix time for the following day may be decreased when authorized by DESIGN ENGINEER.

D. Uniformity Requirements: The RCC plant and delivery system shall combine the materials into a uniform mixture that meets the following uniformity requirements:

Mixer Performance Test	Variability Index, Min
Water content, percent by weight	75
Unit weight of air-free mortar, lb/ft^3	85
Coarse aggregate content, percent by weight	80

E. Mixer Performance Test Procedure:

1. Three samples shall be taken under the direction of DESIGN ENGINEER from the placement surface immediately prior to compaction. This sampling will include the beneficial or detrimental effects of additional handling and remixing from conveying, transferring, and spreading.
2. After the first sample is taken, successive samples shall be obtained after testing of the previous sample is essentially completed. Testing for each sample should be completed within 2 hours after sampling, except for drying, weighing, and calculations.

3. Each sample size shall be approximately 3 cubic feet or 400 pounds of material, and shall include all material through the full depth of the lift. CONTRACTOR shall provide sufficient labor and all necessary platforms, tools, and equipment to obtain the samples, transfer the samples to the Independent Testing Laboratory, and place the samples within the testing laboratory building prior to testing. The samples shall be covered and protected during transport to the testing laboratory and during processing at the testing laboratory.
4. After the samples have been placed within the testing laboratory building, CONTRACTOR shall provide one laborer for 1 hour to help in initial processing of the samples.
5. The Independent Testing Laboratory shall determine water content, unit weight of air-free mortar, and the percentage of coarse aggregate using procedures given by CRD-C 55 with the following changes in procedure:
   a. Samples shall be compacted in three equal layers, each layer compacted for approximately 20 seconds with a TP-400 Hilti Hammer, or equal. The container shall be fitted with a collar so that the surface of the compacted last layer is level with the top of the container.
   b. For determination of the percentage of coarse aggregate, wash approximately 200 pounds or about 1-1/2 cubic feet from the original sample. The sample should be washed in small increments of about 20 pounds in a series of nested screens above the No. 4 screen.

F. DESIGN ENGINEER reserves the right to verify the cement and pozzolan content of the RCC mix in accordance with ASTM D2901 or the USBR Procedure for Determining Cement Content of Soil Cement (Heat of Neutralization Method). Testing shall be conducted at CONTRACTOR's Testing Laboratory. A minimum of five tests for cement and pozzolan content shall be conducted during construction.

2.12 COMPACTION EQUIPMENT

A. Self-propelled vibratory rollers shall be of the double-drum type. They shall transmit a dynamic impact to the surface through a smooth steel drum by means of revolving weights, eccentric shafts, or other equivalent methods. The compactor shall have a gross weight of not less than 20,000 pounds and shall produce a minimum dynamic force of 400 pounds per linear inch of drum width at the operating frequency which is used during construction. The roller shall have a vibrating frequency of at least 1,800 cycles per minute. The roller drum shall be between 4 and 5-1/2 feet in diameter and 5-1/2 to 8 feet in width. The roller shall be operated at speeds not exceeding 1.5 miles per hour. The engine driving the eccentric mass shall have a rating of not less than 125 horsepower. Within the range of the operational capability of the equipment, DESIGN ENGINEER may direct or allow variations to the frequency and speed of operation which result in maximum density at the fastest production rate. At least two self-propelled vibratory rollers in good operating condition and meeting these requirements shall be maintained full time on the project site at all times during production placement. Standby replacement equipment shall be available for functional operation on the placement within 2 hours' time.

B. Hand-Operated Power Tampers: Tampers shall be of a type similar to the Wacker Model GVR 220Y and shall develop a force per blow of at least 1,900 pounds. The amount of rolling and tamping required shall be whatever is necessary for the particular equipment to provide the same degree of compaction as would be attained with four or more passes of the large self-propelled vibratory roller specified above. At least two small rollers and two tampers in good operating condition shall be maintained on the placement area during all production operations. Standby replacement equipment shall be available for functional operation on the placement within 2 hours' time.

C. Vacuum Pickup System: Vacuum pickup system(s) shall be provided for various cleanup operations from the beginning of foundation cleanup to final placement of RCC. Materials to be removed will include, but not be limited to, dust, silt, sand, gravels, angular rocks, contaminated concrete, water, mud, and vegetation. Unit(s) shall be available for use as directed when any CSA or RCC cleanup operation is in progress.

D. Other Equipment: All other equipment (backhoe(s) with vibratory plate, backhoe(s) with immersion-type vibrators, water trucks, power spade to cut nonconforming material away) necessary for the successful completion of RCC but not previously discussed within these Specifications shall be furnished by CONTRACTOR at his expense. Such equipment shall not result in any damage to the RCC, shall be maintained in good operating condition, and shall be operated by skilled CONTRACTOR-provided personnel.

PART 3 EXECUTION

3.1 GENERAL

A. CONTRACTOR shall have produced and stockpiled at least 50 percent of the RCC aggregate required before construction of the test fill. CONTRACTOR shall notify DESIGN ENGINEER and Testing Laboratory Supervisor a minimum of 48 hours before mixing begins for placement of RCC. Mixing and placing shall be performed only in the presence of DESIGN ENGINEER and Testing Laboratory Supervisor unless waived for that specific placement. Placement shall not begin until after all preparations are complete and the DESIGN ENGINEER has approved the preparations for that placement. Prior to beginning RCC placement, CONTRACTOR shall have sufficient, properly operating equipment and all necessary material available on the site. Any delays due to inadequate, defective, or insufficient equipment or operators shall be at CONTRACTOR's expense and will not be grounds for extensions of the milestone or Contract date.

3.2 FOUNDATION PREPARATION, DRAIN GRAVEL, BEDDING CONCRETE, AND FIRST LAYER OF RCC

A. General:

1. Prior to placing drain material, bedding concrete, bedding mortar, and RCC on the foundation and against CSA, the exposed foundation shall

be prepared as specified in Section 02220, FILL AND BACKFILL. No foundation or abutment area shall be covered with any material until it has been accepted in writing by DESIGN ENGINEER. The exposed CSA surface upon which drain gravel will be placed and the north and south abutments shall be cleaned of all loose or deleterious material by scraping, air lance, or hand-powered equipment. Dewatering shall be in full compliance with Section 02140, DIVERSION AND CARE OF WATER. After excavating to limits shown, remove disturbed packets of material and obtain DESIGN ENGINEER approval. At least 2 feet of drain gravel shall be placed upon the bottom of the approved foundation prior to placement of any bedding concrete or RCC. The drain material shall be placed in lifts not exceeding 6 inches and compacted with a minimum of four passes with a vibratory roller weighing at least 15,000 pounds. Take care to ensure that the drain material is not contaminated with dirt or debris material.

2. Three feet of drain gravel shall be placed at the downstream edge of placed RCC. Placement of the drain gravel shall occur after the RCC has attained sufficient strength to withstand compactive effort required without causing damage to RCC. Alternatively, the drain gravel may be place at the same time as RCC; however, the width of the drain gravel shall be increased to prevent contamination such that at least 3 feet of uncontaminated drain gravel is present.
3. The drain gravel shall be placed in lifts not exceeding 6 inches and compacted with a minimum of four passes with a vibratory roller weighing at least 15,000 pounds. Take care to ensure that the drain material is not contaminated with dirt and debris material.
4. Clean surface of existing CSA grade control structure by removing irregularities and loose CSA. The exact shape of the grade control structure is unknown. CONTRACTOR shall remove CSA to within 2 feet horizontally of the shape shown on Drawings and create smooth transitions between different slopes. Place drain gravel against grade control structures as shown and compact as required above.
5. Bedding concrete shall be placed at the interface between the drain gravel and RCC. The first layer of RCC shall be placed on the bedding concrete within 30 minutes of the time that the bedding concrete is placed. Compaction of the bedding concrete placed on the drain material will not be required.

3.3 CLEANING RCC LIFTS

A. General: RCC surfaces contaminated with deleterious substances are required to be cleaned prior to covering with bedding mortar. Prior to placing RCC over the cleaned area, the area of the lift which has been cleaned shall be completely covered with bedding mortar immediately ahead of placing the next lift of RCC.

B. Deleterious Substances: Deleterious substances are any substances that may reduce or prevent bonding between lifts of RCC. Deleterious substances include defective RCC and foreign materials. Defective RCC includes RCC material that is inadequately compacted, dry, loose, improperly cured, or deficient in cementitious content at the lift surface. Foreign materials include, but are not limited to dirt, sand, petroleum products, curing

compound, free water, remaining concrete materials from removed RCC lifts or concrete, and foundation materials from excavation or cleaning operations.

C. Cleaning Procedures: The following methods shall be used to reduce RCC surface contamination by deleterious substances:

1. Liquid substance and solids that can be completely picked up by suction shall be removed by vacuum equipment.
2. Deleterious substances that cannot be adequately removed by vacuum equipment shall be removed by loosening the RCC surface by brushing or scraping by hand or powered equipment to a depth adequate to completely remove all contaminated RCC. Loosened material shall be picked up, removed, and wasted. If the RCC lift is cleaned within 4 hours after being compacted, the cleaned surface shall be rerolled with a vibratory roller or smaller compaction equipment, as appropriate to the size of surface disturbed, and coated with bedding mortar.
3. Surfaces properly cured and less than 4 hours old, contaminated with defective RCC consisting of RCC material loosened by equipment travel, can be rerolled to close the lift surface instead of removing the defective RCC materials and do not require covering with bonding mortar, unless otherwise required.
4. RCC deficient in cementitious content shall be removed.
5. Contaminated surfaces more than 48 hours old shall be cleaned by thoroughly washing the surface with air, water, or high-pressure water jets as required to produce a firm, clean surface and coated with bedding mortar.

3.4 CONVEYING

A. General: RCC shall be conveyed from the RCC plant to the downstream dam foundation using a conveyor belt system. Bedding concrete shall be transported to the dam using conveyor belts or cranes or by pumping. Bedding mortar may be transported by dump truck or by crane. Placement shall be as rapidly and continuously as practicable, by methods which control segregation, contamination, and drying. Methods and equipment for handling, hauling, and depositing the mix shall be subject to the approval of DESIGN ENGINEER. Hauling vehicles will not be allowed to transport RCC from the RCC plant to the dam foundation or to transport bedding concrete. Bedding mortar may be transported in hauling vehicles.

B. Temporary Storage Containers: Interim storage at gob hoppers between conveyance stations shall be provided when direct conveyor systems do not otherwise provide continuous unsegregated delivery to the placement. The gob hoppers shall be constructed with adequate capacity so that the mixing sequence is not stopped or slowed during production if the hauling vehicles are delayed. The gob hoppers shall be constructed with side slopes and gates that allow for the free flow of RCC without segregation or choking. Gob hoppers shall be emptied of all of one mix before being filled with a mix of a different design. Gob hoppers shall be easily moved or elevated with no downtime and without causing any damage to the RCC.

C. Belts: Conveyor belts shall be operated at speeds that meet production requirements and do not segregate materials. If necessary, CONTRACTOR shall provide baffles at the ends of conveyors, within hoppers to limit free falls to a maximum of 8 feet, and at other locations that otherwise cause excessive segregation. Vertical lifts of the RCC mix may be accomplished with bucketed conveyors. Steep inclines may be accomplished using conveyor belts with cleats. The conveyor system shall be designed by personnel fully experienced with belt delivery of mass concrete. The system shall be designed in detail by CONTRACTOR and submitted with the Construction Plan. The equipment shall be specifically designed for continuous operation with no slump concrete. The locations, capacities, speed, reach, and pivot points for all belts shall be indicated. An adequate inventory of replacement components and parts shall be maintained at the jobsite.

D. Chutes: Unless specifically authorized in writing after a satisfactory field demonstration, chutes will not be permitted.

E. Hauling Vehicles: Equipment will not be allowed to track mud or other contamination onto the RCC placement area. This may require using clean crushed rock on haul roads and washing tires of vehicles prior to driving onto the RCC, and other additional measures that may be necessary.

F. Conveyance on RCC Dam: Conveyance of RCC on the dam from the conveyor belt to the final placement location within each lift shall be by conveyor, end dump trucks, or loaders. Depositing and spreading RCC shall be by methods that prevent segregation, contamination, or drying of RCC and prevent contamination or deterioration of previously placed RCC. Any segregation that results during the deposition shall be removed by reworking during spreading. All hauling vehicles shall be operated in a manner that precludes tight turns, sudden stops, or other procedures that damage previously compacted RCC. For belt delivery, the belt shall discharge with a spreading action that does not cause segregation. Truck deposition shall be accomplished with a dump-spread action while the truck is moving. Trucks shall remain on hard RCC surfaces that are at least 4 hours old, except:

1. Trucks may back up on just-placed, uncompacted RCC for actual dumping of RCC.
2. After the completion of RCC for each lift, the end dump trucks are permitted (one time only and without making sudden turns or stops) to drive across freshly compacted RCC to the location necessary for the start of hauling for the next lift. The dump beds shall dump clean with no buildup or hanging of material in corners. The beds may require coved corners and/or bed vibrators.

3.5 PLACING, SPREADING, AND PROTECTION OF RCC

A. General: CONTRACTOR shall provide a full-time RCC placing foreman on the dam foundation during all hours of RCC placement to direct the work on the dam. The RCC shall be placed in as nearly a continuous horizontal operation across the full length of the dam as is practical. It is anticipated that CONTRACTOR shall work at least 6 days per week,

multiple shifts per day, during placement of RCC. Each RCC layer shall be placed and compacted prior to placement of the subsequent layer. Placement shall proceed across the structure by advancing the face of uncompacted RCC "uniformly." Whenever a cold joint at any edge of any lift does occur, it shall be located at least 10 feet from the location of other cold joints that may have previously occurred in the same direction along previous lifts. The cold joint shall be prepared as required in paragraph JOINTS, prior to resumption of RCC placement. No cold joint shall be allowed along the edge of a lift in the upstream-downstream direction for more than one-half of the upstream-downstream dimension of the placement area at that elevation.

B. The RCC construction shall be raised at essentially the same level across its entire area. As nearly as is practical, CONTRACTOR shall expose at one time the surfaces of only one layer, the preceding layer, and the succeeding layer. DESIGN ENGINEER may allow additional layer surfaces to be exposed under special circumstances. As placement of a lift progresses, the exposed edges shall be kept "live" by progressively placing out from them.

C. Operation of tracked equipment on compacted RCC surfaces shall be minimized. Damage to compacted RCC surfaces by tracked equipment shall be repaired by removing all loose, detached material and covering the damaged area with a 1/4-inch to 1/2-inch nominal thickness of bedding mortar prior to spreading the next RCC lift.

D. The interval between mixing and final compaction of RCC shall be no greater than 45 minutes. The mix shall be spread into layers that will, after compaction, be approximately 12 inches thick. Where RCC is spread onto or into bedding mortar or bedding concrete, spreading shall be accomplished before the bedding mortar or bedding concrete has begun to set, or becomes more than 45 minutes old starting from the time when it was batched. All RCC shall be deposited and spread in such a manner that results in minimum segregation.

E. RCC shall be deposited at the location at which it will be spread. Spreading shall be accomplished by tracked dozer or other approved equipment. Dozers shall be a minimum size and weight equivalent to a Caterpillar D-3. There shall be a minimum of one operating dozer for each 200 cubic yards of RCC being placed each hour. The dozers shall be equipped with well-maintained grousers. A front-end loader with operator shall be available to assist with deposition and spreading of RCC as needed in confined areas, at the abutments, and at other locations. The equipment shall be maintained in good operating condition. Spreader box or other spreading and remixing equipment shall not be used.

F. RCC shall be deposited on previously placed and compacted RCC or on bedding mortar placed on previously compacted RCC. The RCC shall then be worked by dozer action to knock down piles or windrows of RCC, and eliminate any segregation prior to final spreading. For final spreading, the RCC shall be spread in unsegregated layers. All surfaces of each layer shall receive at least two passes with the grousers. The dozer(s) shall be operating continuously during the spreading action even if this action results in more than two passes. The equipment shall be maintained in good

operating condition. No RCC or other concrete shall be placed on a previous layer that has been found to be suspect and is being prepared for testing.

G. A laser shall be used in conjunction with hand-carried vertical rods and a rod attached to the spreading equipment to determine elevation and thickness of each layer. The laser shall be of a type that emits a rotating or constant light beam in a fixed plane.

H. All equipment shall not leak or drip oil, grease, or other visible contaminants on the fill. All equipment used for spreading and remixing that leaves the surface of the dam foundation for maintenance or repairs or for any other reason must be cleaned of all contaminants by an approved method before returning to the dam surface.

I. Under no conditions shall a dozer or other tracked vehicle be operated on other than fresh uncompacted RCC. When necessary to remove the tracked vehicle from the dam surface, or move the dozer from one abutment to another, such movements shall be made by loading the vehicle on a rubber-tired trailer, or by crane, or provide other approved method for protecting compacted RCC. Provide protection pads between the grousers and RCC surface, or provide some other approved protective device.

J. CONTRACTOR shall protect RCC against damage until final acceptance by DESIGN ENGINEER and until covered with reinforced concrete. Haul units operating on RCC shall be routed to avoid repeated passes over the same area to minimize rutting or displacing the surface and to benefit overall compaction of the RCC lift.

3.6 COMPACTION

A. General: Within 10 minutes of spreading the layer, each lift of RCC shall be compacted with a minimum of six passes of a self-propelled vibratory compactor. A round trip over the same material shall count as two passes (i.e., from Point A to Point B and return to Point A by same route is two passes). The largest size equipment specified herein and capable of physical and practical operation in the area to be compacted shall be used. In general, large width, self-propelled vibratory rollers shall be used in open areas; small walk-behind vibratory rollers shall be used within 1.5 feet of the downstream face and at irregular areas at the abutments; and hand-guided power tampers shall be used for compaction in any areas that cannot be reached with the drum of a vibratory roller. Thinner layers may be required when compacting with tampers and small rollers. If, after six passes of the roller the density is less than specified, CONTRACTOR shall make additional passes until the RCC meets the minimum density requirements. Operate with sufficient overlap to ensure complete coverage of the entire surface.

B. The edge of all compacted layers against which adjacent RCC is not placed within 20 minutes shall be broken down or trimmed so that the exposed edge is thoroughly compacted and does not contain loose segregated aggregate. Unless otherwise directed by DESIGN ENGINEER, the first pass of the vibratory roller shall be in the static mode. Rollers shall not be

operated in the vibratory mode until they are moving. The RCC shall be compacted uniformly throughout the entire lift. The surface of the compacted RCC shall be dense and sealed with exposed aggregate held firmly in place by mortar. The compacted surface shall be free of tracks or roller marks greater than 1 inch deep. Undulations shall be less than 2 inches. Finish-rolling with the vibratory roller to compact surface defects prior to placing the next lift may be required, provided that the previously placed lift has not set.

C. Density: RCC shall be compacted to a minimum wet density of 98 percent of the optimum compaction density (OCD) value.

D. Determination of OCD Value:

1. General: Because material properties, proportions, and quality may change within Specification limits, maximum attainable density may also change, the OCD method of determining the maximum density shall be used; however, the minimum OCD value will be 94 percent of the theoretical air-free density. A minimum of eight passes of the double-drum roller shall be used to determine the OCD.
2. Initial OCD Determination: The initial OCD value will be determined by DESIGN ENGINEER during placement of the test section. The density of each lift of the RCC shall be determined for each pass of compaction equipment. Density testing shall be done in four locations. Compaction shall continue until the wet density no longer increases. The OCD shall be the average maximum recorded density. The number of roller passes to achieve OCD shall be a guide to the equipment operators of the required compaction necessary to achieve OCD.
3. Subsequent OCD Determination: As RCC placement progresses, subsequent OCD testing shall be performed, initially, at least once every six shifts of RCC placement and a lesser frequency as determined by RESIDENT ENGINEER as placement progresses. CONTRACTOR shall perform OCD testing in the presence of DESIGN ENGINEER following the procedure of testing a lift at four locations after each pass of the roller as specified for the initial OCD determination.

E. Nuclear Gauge: In-place wet density measurements shall be made by the Independent Testing Laboratory using a single-probe nuclear density gauge, hereafter referred to as "nuclear gauge," similar to Troxler Model 3411-B. The Independent Testing Laboratory shall maintain two nuclear gauges in good working condition at the project site at all times. Nuclear gauge testing shall be used in determining the in-place density for all RCC placed to determine whether a minimum of 98 percent of the optimum compaction density value has been achieved.

F. Moisture Content: During the compaction of RCC, the in-place moisture content shall be maintained so that water does not evaporate from the concrete. CONTRACTOR shall not supply additional moisture to the RCC after the completion of mixing with the exception of fog or fine spray. In-place surface moisture content during compaction shall be monitored by the nuclear density gauge.

1. The Independent Testing Laboratory shall test the moisture throughout the lift each hour with the nuclear gauge. The moisture content of the RCC prior to and during compaction shall be distributed uniformly throughout each lift of RCC. As a minimum, the moisture content shall be taken at a minimum of three depths throughout the lift.
2. The moisture content of the RCC shall be determined from the as-batched moisture content of the ingredients including all the water absorbed by aggregates plus the design, as-batched free-water content of the mixture proportions for RCC. This will be compared to the moisture content determined by the nuclear gauge. The moisture content of RCC shall be maintained at the total moisture content of RCC ingredients plus or minus 0.5 percent as determined by the nuclear gauge.

3.7 CURING OF RCC

A. General: The RCC surface shall be kept at a temperature above 35 degrees F for 7 days or until it is covered with the next layer. RCC shall be continuously cured, and curing shall begin immediately after final compacting. The RCC surfaces shall be treated as specified to prevent loss of moisture from the RCC until the required 14-day curing period has elapsed or until immediately prior to placement of other concrete or RCC against those surfaces. Only sufficient time to prepare construction joint surfaces or lift surfaces and to bring them to a clean, saturated, surface dry condition shall be allowed between discontinuance of curing and placement of adjacent RCC or concrete. Improperly cured RCC will be considered defective and shall be removed. DESIGN ENGINEER reserves the right to delay RCC placements due to improper curing procedures until CONTRACTOR implements proper curing procedures that are approved by DESIGN ENGINEER. Any surface that is damaged by erosion that undercuts coarse aggregates shall be treated as a cold joint.

B. Curing: Water will be considered the only acceptable material for curing RCC. Water used for curing shall meet the requirements for water used in mixing RCC. RCC to be cured by water shall be kept continuously moist, but not saturated, for 14 days or until placement of the next lift. The RCC surfaces to be cured by water shall be kept moist by a water truck equipped with mist or fogging equipment supplied; or by a system of pipes and hoses equipped with stationary or portable mist or fogging equipment; or by other approved methods that will keep all exposed surfaces continuously moist without damage to the project. Any method that results in the surface of the RCC becoming dry will be considered an improper curing method. All curing methods are subject to the approval of DESIGN ENGINEER.

3.8 JOINTS

A. General: It is the intent of this Contract to place the entire RCC mass with sufficient continuity and continuance so that it hardens and acts as one monolithic block without continuous horizontal joints or potential planes of separation. The length of time between placement of successive layers of RCC which can be tolerated is defined in hours. When the limits described below are exceeded, a cold joint will be considered to have occurred, and the procedures described below for cold joints shall be followed. All joint

surfaces shall be kept in a clean, uncontaminated, and continuously moist condition until placement of the succeeding concrete. An adequate number of operable nozzles that provide overlapping water, fog, or mists shall be maintained at the placement area at all times. They shall be used as necessary to prevent joint surfaces from drying and shall be supplemented as necessary by mists from hand-held hoses to reach inaccessible areas. The mist or fog shall not be applied in a manner that erodes the fresh RCC surface. It also shall not be applied at a rate that causes ponding at the surface. Water trucks shall be allowed to leave the RCC surface not more than once every 2 hours and for not more than 10 minutes to recharge their tank. Trucks shall not be allowed to drip visible oil or other contaminant on the RCC surface. At least one person 24 hours per day, 7 days per week shall be on duty on the placement with the sole responsibility of operating the water system to maintain the entire surface moist but not overwatered. He may be allowed to perform routine maintenance of nozzles and moving hoses only if these activities do not prevent him from fully accomplishing his responsibility of keeping the entire exposed surface in a continuously damp condition. No payment shall be made for any joint preparation, or cleaning, unless the cold joint was directed by DESIGN ENGINEER.

B. Regular RCC/RCC Lift Joint Treatment: Regular lift joint treatment and maintenance shall include:

1. Maintaining 100 percent of each lift surface continuously moist.
2. Removing all loose contaminants or deteriorated RCC by low pressure washing and vacuuming or hand cleaning, if necessary.
3. Application of a 1/4- to 1/2-inch thick bedding mortar immediately before placement of the next lift over the full width of each lift, contaminated areas, and areas designated by DESIGN ENGINEER. For regular lift joint treatment, no washing or vacuuming will be necessary provided damage, ponded water, or contamination of the lift surface is prevented. It is CONTRACTOR's responsibility to prevent damage and contamination of each lift surface, such as caused by tracking of vehicles or by rainfall, etc.

C. Horizontal Cold Joints: Joints will be classified as needing cold joint treatment when more than 8 hours have passed before placement of the successive layer of RCC. If a joint does not fall into this category, it shall not be considered as a cold joint, and no special treatment is required unless CONTRACTOR failed to meet other requirements of the Specification such as keeping the joint continuously damp, preventing contamination of the joint, etc.

D. Cold joints shall be prepared for the subsequent lift by removing all laitance, loose debris, and contaminants by high-pressure air or water jetting. The cleaning procedure shall expose but not undercut the aggregate and shall be subject to approval. After this initial preparation, the surface shall be left in a damp condition. No dry areas or ponded water will be allowed. A nominal 1/4- to 1/2-inch thickness of bedding mortar shall be spread over the entire lift joint surface before placement of the next RCC layer.

E. Vertical Cold Joints: When it becomes apparent that placement of RCC will be terminated before the entire lift has been completed across the surface area, the RCC edge shall be flattened to a tapered slope no flatter than 1 horizontal to 1 vertical. The tapered edge shall be compacted to the required density. These joints shall be treated as cold joints and bedding mortar applied accordingly. Such occurrences are likely when a breakdown of equipment takes place or when a shutdown is necessary due to climatic factors.

3.9 BEDDING MORTAR AND BEDDING CONCRETE

A. General: The bedding concrete and bedding mortar are to be used specifically for achieving bond between different layers of RCC and foundation drain material and RCC, and for eliminating and preventing segregation or voids along margins or exposed faces of RCC placements. Adjustments to the mix designs may be directed by DESIGN ENGINEER. Surfaces to receive bedding mortar and bedding concrete shall be prepared as specified for RCC. No surfaces to receive a bedding concrete or bedding mortar shall be covered until the prepared surfaces have been accepted by DESIGN ENGINEER and that acceptance has been recorded on an approved checkout form. All surfaces upon which RCC or any concrete or bedding mortar is placed shall be damp and at a surface temperature in excess of 32 degrees F. In no case will the mixes be allowed to dry from the sun or wind.

B. Bedding mortar, a broomable, high portland cement/pozzolan content, shall be used between RCC lifts where designated adjacent to the existing CSA at the abutments and where cold joints occur. Bedding mortar shall be spread with a specially designed rake or broom that evenly distributes the mortar to an average thickness not exceeding 1 inch.

C. Bedding concrete shall be used at the drain material/RCC interface and adjacent to the existing CSA. Bedding concrete shall be applied at a uniform thickness of approximately 3 inches or as directed. At the abutments, bedding mortar shall first be applied followed by the bedding concrete followed by the RCC.

3.10 DOWNSTREAM CLEANUP OF "RAVEL"

A. During construction, spillage over the downstream edge is expected to occur, which will result in an accumulation of loose uncompacted RCC material. Overbuild within the limits specified above is acceptable. Tolerances will be measured between the design lines and the actual profile of the downstream face. CONTRACTOR shall remove spillage and may use it in haul roads or elsewhere for his convenience, but shall not recycle it back into his RCC mix.

3.11 WEATHER

A. General: If unusual adverse weather such as heavy rain, hail, etc., occurs or is forecast to occur during placement, the placing operation shall be suspended until conditions improve.

B. Cold Weather: RCC shall not be placed when ambient air temperatures drop below 28 degrees F or if the surface of the compacted RCC drops below 33 degrees F.

C. Placing During Rain: RCC shall not be placed during rainfall of more than 0.02 inch in 6 minutes. During periods of lesser rainfall, placement of RCC may continue provided moisture content of RCC is within specified limits. During periods of rain or when rain falls on the fresh RCC surface within 3 hours after placement, no heavy equipment or workers shall be allowed on or be in direct contact with freshly compacted RCC until the RCC has gained sufficient strength (no less than 3 hours after RCC placement) to prevent rutting, pumping, intermixing of rainwater with the RCC, or other damage to the RCC. Special precautions shall be taken to prevent contamination of the bedding mortar or RCC by ponded water. After the RCC has hardened sufficiently to allow equipment and workers on the surface without damage, but no sooner than 3 hours after RCC placement, the RCC surface shall be washed to break up laitance and/or mudlike coating on the surface. The washing shall not undercut any coarse-size aggregate. Pickup of the wash debris shall be accomplished with a truck-mounted vacuum or other approved system. The washing action is critical in order to remove coatings formed during light rains that, if left in place, would act as bond breakers between each lift.

D. Hot Weather: The temperature of the RCC just prior to compaction shall be controlled so that it does not exceed 80 degrees F. When RCC temperatures measured 10 minutes after mixing exceed 75 degrees, CONTRACTOR shall immediately start sprinkling coarse aggregate stockpiles or initiate other means to reduce temperature of freshly mixed RCC.

E. Uncompacted RCC and compacted RCC less than 8 hours old shall be protected from precipitation. Uncompacted RCC exposed to precipitation exceeding the requirements herein specified shall be removed by and at the expense of CONTRACTOR. CONTRACTOR shall provide such protection to prevent erosion of RCC whenever such precipitation, either periodic or sustaining, is imminent or occurring.

F. When precipitation appears imminent, CONTRACTOR shall immediately make ready at the placement site all materials, such as plastic sheeting or other waterproof sheeting as approved by RESIDENT ENGINEER, which may be required for protection of the RCC. RESIDENT ENGINEER may delay placement of RCC until adequate provisions for protection against weather are made.

3.12 QUALITY CONTROL

A. General:

1. CONTRACTOR shall establish and maintain an effective quality control system for the Project. This system shall be his means of ensuring compliance with Contract requirements and of maintaining records of his quality control. The program shall include, but not be limited to, testing cement and pozzolan, aggregate gradation,

aggregate moisture, mixing procedures and mix proportions at the batch plant, ensuring adequate materials are on hand, placement, compaction, curing, and all other tests, inspections, and controls necessary to ensure compliance with the Contract Documents.

2. All quality control tests shall be performed in strict accordance with the applicable standard(s) identified herein and identified in Section 03300, CAST-IN-PLACE CONCRETE. The quality control system for RCC shall be established by CONTRACTOR and be submitted to DESIGN ENGINEER with the Construction Plan. CONTRACTOR shall supply all equipment and provide qualified personnel for fulfillment of his quality control system. No aggregate production or RCC placement will be allowed until CONTRACTOR has received approval of an acceptable quality control system. CONTRACTOR's quality control system shall address all quality control in a manner similar in nature to the quality control program established in the following paragraphs. If, at any time, in the opinion of DESIGN ENGINEER, CONTRACTOR's proposed system is inadequate or fails to ensure compliance with these Documents, CONTRACTOR will be required to adopt a new system which, at a minimum, conforms strictly to the requirements stated in the following paragraphs and in this Document.

B. Cement and Pozzolan:

1. Testing: Each 500 tons of cement and pozzolan shall be tested by CONTRACTOR's Testing Laboratory from samples obtained at the Project site at the direction of DESIGN ENGINEER. Access shall be granted as required to inspect storage and to sample for check testing.

2. Action Required: Materials not meeting Specifications shall be promptly removed from the site of the work at CONTRACTOR's expense. Materials which have not been used within 6 months after testing shall be retested at the expense of CONTRACTOR and shall be rejected if test results are not satisfactory. All rejected material shall be promptly removed from the site of the work at CONTRACTOR's expense.

C. Aggregate Moisture Determination:

1. Testing: At least once during each day of placement for each aggregate size used, moisture content determinations shall be made by the Independent Testing Laboratory in accordance with ASTM C566 using oven-dry, hot plate, and microwave procedures. The location from which the sample is selected shall be determined by DESIGN ENGINEER.
2. Action Required: If there is a discrepancy between the test results and the verification tests, immediate steps shall be taken to identify the source of the problem and correct it so that accurate field determinations are obtained. When moisture content determinations indicate a change in water entering the mix with the aggregates, the placing foreman shall be contacted to see if a corresponding adjustment in water added at the mixer is necessary to obtain maximum compaction at the placement site.

D. Aggregate Gradations:

1. Testing: At least once during each shift that RCC is placed and prior to use of the aggregate, gradations shall be checked by the Independent Testing Laboratory in accordance with ASTM C136 for each aggregate size used and for the combined gradation of all aggregates batched at the designated proportions for the RCC. The location from which samples are taken will be selected by DESIGN ENGINEER. Provisions shall be made for accurate sampling of aggregates on the feed belts.
2. Action Required: Whenever a test result is outside of the Specification limits, a recheck sample shall be taken. If the recheck sample is outside of the Specification limits, the process shall be considered out of control, and positive steps shall be taken by CONTRACTOR to rectify the situation. DESIGN ENGINEER will advise CONTRACTOR if production and placement shall be stopped at that time. CONTRACTOR shall be responsible for all costs incurred as a result of stopping any concreting operations due to out-of-specification materials.

E. Material Finer than the No. 200 and No. 50 Sieves:

1. Testing: At least once during each day, during the period of RCC production, tests shall be made by the Independent Testing Laboratory to determine the amount of material passing the No. 200 sieve in accordance with ASTM C117. Washing of the aggregates shall be used to accumulate all minus 200 material.
2. Liquid limit and plasticity indexes shall be determined by the Independent Testing Laboratory in accordance with ASTM D4318, modified to test the minus No. 50 material. After it has been established that a problem does not exist, and if production procedures remain constant, continued testing will be required once per week unless, in the opinion of DESIGN ENGINEER, a problem develops and recheck testing is warranted.
3. Action Required: When testing for material finer than the No. 50 sieve indicates excessive quantity or plasticity, corrective action will be determined by DESIGN ENGINEER.

F. RCC Plant Control:

1. Routine Control and Reporting: When the RCC plant is operating, the measurement of all constituent materials including cement, pozzolan, aggregate, and water shall be continuously controlled. The aggregate weights and amount of added water to compensate for free moisture in the aggregates shall be adjusted as necessary. A daily report shall be prepared indicating the type and source of cement and pozzolan used during that day; the amount, type, and source of admixtures used; aggregate used; required mix proportions per cubic yard for each mix used; the amount of water as free moisture in aggregate; and the aggregate and water weights per cubic yard for each mix of RCC made during plant operation.

G. Scales for Weigh Batching:

1. Tests and Checking: The accuracy of scales shall be checked by test weights prior to the startup of concreting and RCC operations. Such tests shall also be made whenever there are variations in properties of the RCC that could result from batching errors. The accuracy of each batching device when weigh batching procedures are used shall be routinely checked during a weighing operation by noting and recording the required weight and the weight actually batched. Rechecks shall be made at least every week of operation thereafter and whenever there are variations in the properties or control of RCC that could result from batching errors. Tests shall be made in the presence of DESIGN ENGINEER.
2. Action Required: Whenever either the weighing accuracy or batching accuracy is found not to comply with Specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made.

H. Volumetric Feed Calculations:

1. Tests and Checking: The accuracy of volumetric feeds shall be checked by CONTRACTOR in the presence of DESIGN ENGINEER by collecting all material delivered during a unit of time to the mixer and also by washout tests of material exiting from the mixer. Suitable methods and equipment shall be provided for obtaining and handling samples at the concrete plant. The weight of material corresponding to a standard time interval and the resulting proportions of materials per cubic yard shall be determined. The accuracy of volumetric feeds shall be determined at least three times during checkout of the concrete plant prior to production operations and RCC placement. Rechecks shall be made at least every week of operation thereafter and whenever there are variations in the properties of RCC that could result from volumetric feed errors. The sample shall be of sufficient size to give accurate determinations, and calibration may require weights in excess of 500 pounds per item checked.
2. Action Required: Whenever the volumetric feed is found not to comply with Specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made.

I. Testing RCC Mix:

1. General:
   a. Fresh RCC shall be sampled and tested by the Independent Testing Laboratory for compliance with the Specifications and for additional information required by DESIGN ENGINEER. Samples and tests will generally be made at the placing location at the time of placement. CONTRACTOR shall provide a method of readily obtaining representative RCC samples from the plant and gob hopper locations and the surface of the placement.
   b. Action Required: RCC that does not conform to the Specifications as determined by tests or visual inspections by CONTRACTOR's quality control engineer or DESIGN

ENGINEER shall not be delivered to the dam foundation or shall be removed.

2. Temperature:
   a. Testing: At least one test of temperature shall be made by the Independent Testing Laboratory at the batch plant and at the placement on a randomly selected batch of RCC used per shift of placement. Additional tests shall be made when rapid set time or workability loss is reported by the placing foreman or DESIGN ENGINEER's inspector, when cold weather problems occur, or when directed by DESIGN ENGINEER. The temperature of air and RCC shall be recorded during the period of cure and when cold weather protection restrictions are applicable.
   b. Action Required: Whenever the mix temperature at the placement falls below 40 degrees F or is above the temperature specified herein, CONTRACTOR shall notify DESIGN ENGINEER immediately. All other temperatures shall be included as standard data in the quality control reports.
3. Moisture Content:
   a. Tests and Checking: At least once every hour at the placement site (immediately after compaction), the moisture content shall be determined by the Independent Testing Laboratory on the RCC mix using a nuclear gauge in the direct transmission mode. The probe shall be driven to a depth of at least 11 inches for each reading. The gauge shall be calibrated against oven-dry samples of the RCC mix. If, after 3 days of production placement, consistent moisture control is achieved, the rate of testing may be decreased to one test per 4 hours at the plant and one test per 4 hours at the placement. In any case, at least three tests shall be made in different areas for each lift of RCC placed. The placing foreman shall continuously monitor the apparent effectiveness of compaction equipment from a visual standpoint, and shall notify the plant mixing foreman and request adjustment whenever the mix becomes too dry or too wet. Within 2 hours of the start of each day's placement, the Testing Laboratory Supervisor shall provide to DESIGN ENGINEER the average test results for the previous day, number of tests, standard deviation, and moving average of the last 10 shifts. Each recorded reading shall be the average of four readings at each probe location taken in each quadrant of a circle obtained by rotating the gauge 90 degrees after each reading.
   b. Action Required: Whenever moisture content tests indicate a change from what has been established as the optimum batching and placing moisture for maximum density and efficiency of compaction equipment, a corresponding adjustment shall be made in the mix water added at the concrete plant and the adjustment shall be noted. Whenever the placing foreman observes a condition of moisture that begins to consistently allow the vibratory rollers to sink excessively in the mix, cause excessive paste to develop at the surface, or leave an open appearing unconsolidated surface, an adjustment shall be made in the mix water added at the plant, and the adjustment shall be noted.

4. Density:
   a. Tests and Checking: At least once every 2 hours during placement, the density of RCC after compaction shall be determined by the Independent Testing Laboratory with a nuclear gauge previously calibrated against each mix used. The calibration shall be against the applicable RCC mix compacted in an approximately 1-cubic yard rigid timber box weighed empty and full. The nuclear gauge shall be calibrated at least once every 2 weeks during RCC placement. DESIGN ENGINEER will have access to the gauges at all times and shall be allowed to use it for quality assurance check tests. Each layer of RCC shall be tested by the nuclear gauge in at least six separate locations for density. The direct transmission mode shall be used, and readings shall be taken in each quadrant of a circle obtained by rotating the gauge 90 degrees each after each reading around the transmission probe. The probe shall be driven to a depth of 11 inches, plus or minus 1 inch, for each reading.
   b. Action Required: Whenever the nuclear gauge indicates density less than the specified density, a retest shall be made. If the retest indicates unacceptable density, DESIGN ENGINEER shall be notified, additional rolling shall be immediately provided, and a determination shall be made as to whether the lower density resulted from insufficient passes of the roller or a change in the mix properties. If the mix properties have changed, adjustments such as increasing or decreasing the moisture content shall be made at the batch plant. If the problem persists, CONTRACTOR, with the approval of DESIGN ENGINEER, shall adjust the proportions of aggregates, cement, and/or pozzolan. CONTRACTOR shall determine the OCD as specified herein. If the lower density is the result of incomplete rolling, the operator shall be notified, and DESIGN ENGINEER may require removal of the incompletely compacted material. If the same operator repeatedly rolls less than the necessary number of passes, he shall be replaced with a different operator.
5. Mixer Performance Testing:
   a. Tests and Checking: Mixer performance tests shall be completed by the Independent Testing Laboratory during mixer trial runs prior to start of placement of RCC in the test fill, during placement of RCC in the test fill, and a minimum of once every six shifts during the initial 2 weeks of placement of RCC in the dam. The frequency of mixer performance testing may be increased or decreased by DESIGN ENGINEER based on the results of testing and based on observation of materials during placement. The Independent Testing Laboratory shall prepare a report for each mixer performance test using the format shown hereinafter, including calculation of the variability index for each test.
   b. Action Required: Should any mixer at any time fail the mixer performance tests, its use shall be discontinued until it is repaired and additional trial runs indicate satisfactory completion of mixer performance tests.

J. RCC for Compressive Strength Tests:

1. One set of 6-inch by 12-inch RCC specimens shall be cast for each two lifts of RCC placed. The Independent Testing Laboratory shall perform all work associated with casting, curing, and testing specimens at the onsite testing laboratory. Compressive strengths shall be determined at 7, 14, 28, 90, and 180 days. DESIGN ENGINEER may modify testing ages. At completion of construction, all RCC and other concrete specimens not tested onsite shall be transported by the Independent Testing Laboratory to its offsite laboratory for proper storage and testing.
2. Furnish clean molds for 6-inch by 12-inch RCC test cylinders for testing. Forms for 6-inch by 12-inch cylinders shall be reusable, split-steel type with plastic liners, conforming to ASTM C470. The RCC cylinders may be stored for a week in the plastic liners after which the molds are removed. Sufficient quantities of split-steel forms and plastic form liners shall be maintained to meet the testing frequency. Specimens shall be fabricated, cured, and tested in accordance with ASTM C31 and ASTM C39, except that fabrication of cylinders shall be as modified below.
3. Samples of RCC shall be screened of the plus 1-1/2-inch aggregate. Compact RCC in three equal layers, each compacted for approximately 25 seconds with a TP-400 Hilti Hammer equipped with a 1/2-inch thick metal plate approximately 5-1/2 inches in diameter. No additional weight shall be added.
4. CONTRACTOR shall provide an acceptable area at the plant that can be used for adequate concrete sampling and initial cure and protection of prepared test specimens.

K. Coring: After completion of RCC placement, CONTRACTOR shall extract and prepare RCC cores at two locations in the dam foundation in accordance with ASTM C42. The equipment shall include a diamond drill and a double-tube type core-barrel. Locations of drill holes shall be selected by DESIGN ENGINEER. CONTRACTOR shall be required to extract up to 10 feet of drilled core from each location.

L. Reports: Concrete plant control reports and all results (both passing and failing) of testing shall be reported daily to DESIGN ENGINEER. Routine written reports shall be delivered to DESIGN ENGINEER within 1 day following the date of the test or inspection. These requirements do not relieve CONTRACTOR of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. DESIGN ENGINEER has the right to examine all CONTRACTOR quality control records.

RIO SALADO PROJECT
DOWNSTREAM DAM
MIXER PERFORMANCE TESTING

Technician's Name _____ Date:_____

Supervising Engineer _____ Time:_____

RCC Mix Design _____

	Sample 1	Sample 2	Sample 3
Location of Sample (elevation/offset)			
Date/Time			
Compacted Unit Weight (lb/ft^3)			
Air Content (%)			

	Sample 1	Sample 2	Sample 3	Vari-ability Index	Minimum Index	Result Pass/ Fail
Water Content (%)					75	
Unit Weight of Air-Free Mortar (lb/ft^3)					85	
Coarse Aggregate Content (%)					80	

Note: Variability Index = smallest value/largest value x 100

REMARKS:_____

_____

_____

_____

_____

_____

END OF SECTION

SECTION 03370
CONCRETE CURING

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Curing methods proposed.
2. Manufacturers' data for the following products:
   a. Evaporation retardant.
   b. Curing compound.

B. Quality Control Submittals:

1. Curing Compound: Manufacturer's Certificate of Compliance showing moisture retention requirements.

PART 2 PRODUCTS

2.1 MATERIALS

A. Curing Compound:

1. Solvent-based, high chlorinated rubber solids content curing compound meeting requirements of ASTM C309-89.
   a. Moisture Loss: 0.030 gm/square cm/72 hours maximum.
   b. Capable of meeting moisture retention with one coat.
2. Manufacturers and Products:
   a. Master Builders Co., Cleveland, OH; Masterkure CR.
   b. Euclid Chemical Co., Cleveland, OH; Euco Super Floor Coat.
   c. No "or-equal" or substitute products will be considered.

B. Evaporation Retardant:

1. Optional: Fluorescent color tint that disappears completely upon drying.
2. Manufacturers and Products:
   a. Master Builders Co., Cleveland, OH; CONFILM.
   b. Euclid Chemical Co., Cleveland, OH; Eucobar.
   c. No "or-equal" or substitute products will be considered.

C. Retardant for Exposed Aggregate Finish on Slabs:

1. Manufacturers and Products:
   a. Preco Industries, Plainview, NY; EAC-S.
   b. Sika Chemical Corp., Lyndhurst, NJ; Rugasol.
   c. Conrad Sovig Co., San Francisco, CA; Conreveal Top Surface.
   d. Burke Co., San Mateo, CA; Burke True Etch Surface Retarder.
   e. Euclid Chemical Co., Cleveland, OH; Surface Retarder S.

D. Water: Clean and potable, containing less than 50 ppm of chlorides.

PART 3 EXECUTION

3.1 CURING OF CONCRETE

A. Use one of the following methods as approved by RESIDENT ENGINEER:

1. Walls and Piers:
   a. General: Where walls are to receive coatings, painting, cementitious material, or other similar finishes, or where solvent-based coatings are not permitted, use only water curing procedures.
   b. Method 1: Leave concrete forms in place and keep entire surfaces of forms and concrete wet for 14 days.
   c. Method 2: Apply curing compound, where allowed, immediately after removal of forms.
   d. Method 3: Continuously sprinkle with water 100 percent of exposed surfaces for 14 days starting immediately after removal of forms.
2. Slabs and Curbs:
   a. Method 1: Protect surface by water ponding for 14 days.
   b. Method 2: Cover with burlap or cotton mats and keep continuously wet for 14 days.
   c. Method 3: Cover with 1-inch layer of wet sand, earth, or sawdust, and keep continuously wet for 14 days.
   d. Method 4: Continuously sprinkle exposed surface for 14 days.
   e. Other agreed upon method that will keep moisture present and uniform at all times on surface of slabs. Do not use curing compounds.
   f. Protect slabs during cold weather with plastic sheets or other material inside required heated enclosure if foot traffic is permitted on slabs.
3. Exposed Aggregate:
   a. Spray entire area including the test panel with surface retarder at a rate recommended by the manufacturer. Be careful not to get on adjacent surfaces.
   b. Immediately cover with plastic sheeting while curing continues.
   c. Check sample panel for proper timing for aggregate exposure.
   d. Accomplish exposure of selected aggregates by removing the surface matrix by washing with water and brushing with a stiff plastic bristled brush as soon as concrete has set sufficiently to support the weight of a person.
   e. Exposure: No greater than 1/3 the average diameter of aggregate, no less than 1/4.
   f. Once a uniform exposure is obtained, continue flushing with water until there is no noticeable cement film on the aggregate exposed and the water runs clear.

   g. Continue curing using method number 2 above.

B. Use only water curing methods where solvents in the curing compounds are prohibited by state or federal air quality laws.

C. Use only water curing where additional finishes such as clear sealer, hardeners, painting, and other special coatings are required.

3.2 EVAPORATION RETARDANT APPLICATION

A. Spray onto surface of fresh flatwork concrete immediately after screeding to react with surface moisture.

B. Reapply as needed to ensure a continuous moist surface until final finishing is completed.

3.3 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at site in accordance with Section 01640, MANUFACTURERS' SERVICES, for installation assistance, inspection, and certification of proper installation for products specified.

B. Provide curing compound manufacturer's representative to demonstrate proper application of curing compound to show coverage in one coat.

END OF SECTION

SECTION 03600
GROUT

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings: Product data of grouts.

B. Quality Control Submittals:

1. Manufacturer's Certificate of Compliance:
   a. Grout free from chlorides and other corrosion-causing chemicals.
   b. Nonshrink grout properties of Categories II and III, verifying expansion at 3 or 14 days will not exceed the 28-day expansion and nonshrink properties are not based on gas or gypsum expansion.
2. Manufacturer's Certificate of Proper Installation.
3. Statements of Qualification: Nonshrink grout manufacturer's representative.
4. Test Reports:
   a. Test report for 24-hour evaluation of nonshrink grout. Independent testing laboratory to certify that testing was conducted within the past 18 months.
   b. Test results and service report from the demonstration and training session, and from field tests.
   c. Field test reports and laboratory test results for field-drawn samples.

1.2 QUALIFICATIONS

A. Nonshrink Grout Manufacturer's Representative: Authorized and trained representative of grout manufacturer. Minimum of 1-year experience that has resulted in successful installation of grouts similar to those for this Project.

1.3 GUARANTEE

A. Manufacturer's guarantee shall not contain disclaimer on the product data sheet, grout bag, or container limiting responsibility to only the purchase price of products and materials furnished.

B. Manufacturer guarantees participation with CONTRACTOR in replacing or repairing grout found *defective* due to faulty materials, as determined by industry standard test methods.

PART 2 PRODUCTS

2.1 NONSHRINK GROUT SCHEDULE

A. Furnish nonshrink grout for applications in grout category in the following schedule:

Application	Temperature Range	Max. Placing Time	
	40 to 100 deg F	20 min	Greater than 20 min
Filling tie holes	I	I	I
Blockouts for gate guides	I or II	I	II
Precasts joints	I or II	I	II
Column baseplates	I or II	I	II
Machine bases 25 hp or less	II	II	II
Machine bases 26 hp and up	III	III	III
Baseplates and/or soleplates with vibration, thermal movement, etc.	III	III	III

2.2 NONSHRINK GROUT

A. Category I:

1. Nonmetallic and nongas-liberating flowable fluid.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Test in accordance with ASTM C1107-91:
   a. Flowable consistency 140 percent, five drops in 30 seconds, in accordance with ASTM C230-90.
   b. Flowable for 15 minutes.
4. Grout shall not bleed at maximum allowed water.
5. Minimum strength of grout, 3,000 psi at 3 days, 5,000 psi at 7 days, and 7,000 psi at 28 days.
6. Manufacturers and Products:
   a. Master Builders Co., Cleveland, OH; SET GROUT.
   b. Euclid Chemical Co., Cleveland, OH; NS Grout.
   c. Dayton Superior Corp., Miamisburge, OH; Sure-Grip High Performance Grout.

B. Category II:

1. Nonmetallic, nongas-liberating flowable fluid.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.

4. Test in accordance with CRD-C621-83 and ASTM C1107-91, Grade B:
   a. Fluid consistency 20 to 30 seconds in accordance with CRD-C611-81.
   b. Temperatures of 40, 80, and 100 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of grout, 2,500 psi at 1 day, 4,500 psi at 3 days, and 7,000 psi at 28 days.
7. Maintain fluid consistency when mixed in 1- to 9-yard loads in ready-mix truck.
8. Manufacturers and Products:
   a. Master Builders Co., Cleveland, OH; Master Flow 928.
   b. Five Star Products Inc., Fairfield, CT; Five Star 100.
   c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.

C. Category III:

1. Metallic and nongas-liberating flowable fluid.
2. Prepackaged aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with CRD-C621-83 and ASTM C1107-91, Grade B:
   a. Fluid consistency 20 to 30 seconds in accordance with CRD-C611-81.
   b. Temperatures of 40 and 100 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of grout, 4,000 psi at 1 day, 5,000 psi at 3 days, and 9,000 psi at 28 days.
7. Maintain fluid consistency when mixed in 1- to 9-yard loads in ready-mix truck.
8. Manufacturers and Products: Master Builders Co., Cleveland, OH; EMBECO 885.

PART 3 EXECUTION

3.1 NONSHRINK GROUT

A. General: Mix, place, and cure nonshrink grout in accordance with grout manufacturer's representative training instructions.

B. Form Tie or Through-Bolt Holes: Provide nonshrink grout, Category I and II, fill space with dry pack dense grout hammered in with steel tool and hammer. Through-bolt holes, coordinate dry pack dense grout application with vinyl plug in Section 03100, CONCRETE FORMWORK and bonding agent in Section 03300, CAST-IN-PLACE CONCRETE.

3.2 FIELD QUALITY CONTROL

A. Evaluation and Acceptance of Nonshrink Grout:

1. Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer's representative.
2. Perform flow cone and bleed tests, and make three 2-inch by 2-inch cubes for each 25 cubic feet of each type of nonshrink grout used. Restraining caps for cube molds in accordance with CRD-C-621-83.
3. For large grout applications make three more cubes, one more flow cone test, including bleed test for each additional 25 cubic feet of nonshrink grout placed.
4. Consistency: As specified in Article NONSHRINK GROUTS. Reject grout with consistencies outside range requirements.
5. Segregation: As specified in Article NONSHRINK GROUTS. Reject grout when aggregate separates.
6. Nonshrink grout cubes shall test equal to or greater than minimum strength.
7. Strength Test Failures: Reject nonshrink grout work failing strength tests, remove and replace grout.
8. Perform bleeding test to demonstrate grout will not bleed.
9. Store cubes at 70 degrees F.
10. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with CRD-C621-83.

3.3 MANUFACTURER'S SERVICES

A. General:

1. Coordinate demonstrations, training sessions, and applicable site visits with grout manufacturer's representative.
2. Provide and conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurement, cube testing, application, and curing for each category and type of nonshrink grout.
3. Coordinate necessary equipment and materials are available for demonstration.

B. Training:

1. Grout manufacturer's representative shall train CONTRACTOR to preform grout work.
2. Establish location at site and schedule time for grout manufacturer's demonstration and training session of proposed nonshrink grouts. Mix nonshrink grouts to required consistency, test, place, and cure on actual Project, e.g., baseplates and tie holes to provide actual on-the-job training.
3. Use minimum of five bags for grout Category II and Category III. Mix grout to fluid consistency and conduct flow cone and two bleed tests, make a minimum of six cubes for testing of two cubes at 1, 3, and 28 days. Use remaining grout for final Work. Training includes methods for curing grout.
4. Mix sufficient grout Category I for minimum of 15 tie holes.

5. Transport test cubes to an independent test laboratory and obtain test reports.

3.4 SUPPLEMENTS

A. The supplement listed below, following "END OF SECTION," is part of this Specification.

1. 24-Hour Evaluation of Nonshrink Grout Test Form and Grout Testing Procedures.

END OF SECTION

_____
(Test Lab Name)

_____
(Address)

_____
(Phone No.)

24-HOUR EVALUATION OF NONSHRINK GROUT TEST FORM

OBJECTIVE: Define standard set of test procedures for an independent testing laboratory to perform and complete within a 24-hour period.

SCOPE: Utilize test procedures providing 24-hour results to duplicate field grouting demands. Intent of evaluation is establish grout manufacturer's qualifications.

PRIOR TO TEST: Obtain **[A: five] [B:]** bags of each type of grout.

1. From intended grout supplier for Project.
2. **[C: Five] [D:]** bags of grout shall be of same lot number.

ANSWER THE FOLLOWING QUESTIONS FOR GROUT BEING TESTED FROM LITERATURE, DATA, AND PRINTING ON BAG:

A.	Product data and warranty information contained in company literature and data?	Yes_____	No_____
B.	Literature and bag information meet specified requirements?	Yes_____	No_____
C.	Manufacturer guarantees grout as specified in Article GUARANTEE?	Yes_____	No_____
D.	Guarantee extends beyond grout replacement value and allows participation with CONTRACTOR in replacing and repairing *defective* areas?	Yes_____	No_____
E.	Water demands and limits printed on bag?	Yes_____	No_____
F.	Mixing information printed on the bag?	Yes_____	No_____
G.	Temperature restrictions printed on bag?	Yes_____	No_____

*Rejection of a grout will occur if one or more answers are noted NO.

GROUT TESTING PROCEDURES

A. Bagged Material:

1. List lot numbers. _____

2. List expiration date. _____

3. Weigh bags and record weight. _____

RESIDENT ENGINEER will disqualify grout if bag weights have misstated measure plus or minus 2 pounds by more than one out of five bags. (Accuracy of weights is required to regulate amount of water used in mixing since this will affect properties.)

B. Mixing and Consistency Determination:

1. Mix full bag of grout in 10-gallon pail.

2. Use electric drill with a paddle device to mix grout (jiffy or jiffler type paddle).

3. Use maximum water allowed per water requirements listed in bag instructions.

4. Mix grout to maximum time listed on bag instructions.

5. In accordance with CRD-C611-81 (flow cone) determine time of mixed grout through the flow cone. _____ seconds

6. Add water to attain 20- to 30-second flow in accordance with CRD-C611-81.

7. Record time of grout through cone at new water demand. _____ seconds

8. Record total water needed to attain 20- to 30-second flow. _____ pounds

9. Record percent of water. _____ percent

C. When fluid grout is specified and additional water is required beyond grout manufacturer's listed maximum water, CRD-C621-83 will be run at new water per grout ratio to determine whether grout passes using actual water requirements to be fluid. Use new water per grout ratio on remaining tests.

D. Bleed Test:

1. Fill two gallon cans half full of freshly mixed grout at ambient temperatures for each category and at required consistency for each.

2. Place one can of grout in tub of ice water and leave one can at ambient temperature.

3. Cover top of both cans with glass or plastic plate preventing evaporation.

4. Maintain 38 to 42 degrees F temperature with grout placed in ice and maintain ambient temperature for second container for 1 hour.

5. Visually check for bleeding of water at 15-minute intervals for 2 hours.

6. Perform final observation at 24 hours.

If grout bleeds a small amount at temperatures specified, grout will be rejected.

E. Extended Flow Time and Segregation Test (for Category II):

1. Divide the remaining grout into two 3-gallon cans. Place the cans into the 40 degree F and 100 degree F containers and leave for 20, 40, and 60 minutes. Every 20 minutes remove and check for segregation or settlement of aggregate. Use a gloved hand to reach to the bottom of the can, if more than 1/4 inch of aggregate has settled to the bottom or aggregate has segregated into clumps reject the grout.

2. Right after the settlement test mix the grout with the drill mixer for 10 seconds. Take a CRD-C611-81 flow cone test of grout and record flow time. Maintain this process for 1 hour at ambient temperatures of 40 and 100 degrees F.

   a. 20 min _____, sec. @ 40 degrees F.
   b. 40 min _____, sec. @ 40 degrees F.
   c. 60 min _____, sec. @ 40 degrees F.
   d. 20 min _____, sec. @ 100 degrees F.
   e. 40 min _____, sec. @ 100 degrees F.
   f. 60 min _____, sec. @ 100 degrees F.

All Category II grout that will not go through the flow cone with continuous flow after 60 minutes will be disqualified.

_____ _____
Qualified Disqualified

F. 24-Hour Strength Test:

1. Using grout left in mixing cans in accordance with CRD-C621-83 for mixing and consistency determination test and for extended time flow test, make minimum of nine cube samples.

2. Store cubes at 70 degrees F for 24 hours.

3. Record average compressive strength of nine cubes at 24 hours.

Grout will be disqualified if 24-hour compressive strengths are under 2,500 psi for grouts claiming fluid placement capabilities.

Grouts that have not been disqualified after these tests are qualified for use on the Project for the application indicated in Nonshrink Grout Schedule.

Signature of Independent Testing Laboratory

Date Test Conducted

SECTION 04230
REINFORCED UNIT MASONRY

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Grout mix design proposed.
2. Mortar mix design proposed.

B. Samples:

1. Individual Samples of each type of masonry unit to be used on Project.
2. Two each, Samples of textured, glazed, sound absorbing, and brick units for selection of color and texture.

C. Quality Control Submittals:

1. Method of placing grout.
2. Certified field test results within 5 days of performing specified tests.

1.2 QUALITY ASSURANCE

A. Mockups:

1. Lay up two sample panels at the site; one for each Dam Control Building.
2. Dimensions: Minimum 8 feet high by 4 feet long or as necessary to illustrate all conditions and features of the masonry construction as shown on the Drawings.
3. Leave intact for approval of RESIDENT ENGINEER and until acceptance of the permanent masonry work and then remove.
4. Panel shall be used for color verification, quality of finished joints, and sandblasting techniques, methods, and approvals.

B. Fog Spray: Provide demonstration, prior to starting Work, of fog spray nozzles for curing mortar.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Keep lime and other ingredients dry.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not lay masonry when ambient temperature is below 32 degrees F on a rising temperature or below 40 degrees F on a falling temperature, or when there is a probability of such conditions occurring

within 48 hours, unless written approval of procedures for protection from freezing is obtained.

B. Moisture Protection: Protect masonry construction from loss of moisture during curing period of 7 days when ambient air temperature is 90 degrees F or greater and when relative humidity is less than 50 percent.

PART 2 PRODUCTS

2.1 MASONRY UNITS

A. General:

1. Furnish or cut special shapes for corners, jambs, lintels, and other areas shown or required.
2. Special units shall match color and texture of standard units.
3. Where units are placed so end of a unit is exposed, such as at a corner or intersection, the exposed end of that block shall have surface to match color and texture of sides of other units.
4. Furnish sound, dry, clean units free of cracks, prior to placing in structure.
5. Vertical Cells to be Grouted: Capable of alignment sufficient to maintain clear, unobstructed continuous vertical cell measuring minimum 2 inch by 3 inch.
6. Masonry unit size and shape shall allow for all placement patterns to prevent materials such as grout or poured insulation from escaping from cell being filled to adjacent cells where material is not intended to be placed.

B. Standard Concrete Masonry Units:

1. ASTM C90-90, Type I for arid humidity conditions of use; normal weight.
2. Size: 16 inches long by 8 inches high by 8 inches thick, and as noted on Drawings for special units and cap blocks.
3. Color of Units: Natural grey, unless noted on Drawings as integral color.
4. Surface Texture on Exposed Surfaces: Smooth.

C. Split Face Concrete Masonry Units:

1. Same size, type, and color as standard units.
2. Surface Texture: Split face on exterior faces.

D. Slump Block Concrete Masonry Units:

1. ASTM C90-90, Type I for arid humidity conditions of use; normal weight.
2. Size: 16-inches long by 4-inches high by 8-inches or 12-inches wide, as shown on Drawings.
3. Surface texture on exposed surfaces: Slump.
4. Color of Units: "Purple Haze" as manufactured by Supperlite Corp., Phoenix.

2.2 MORTAR AND GROUT MATERIALS

A. Cement: ASTM C150-89, Type II, portland cement.

B. Lime: ASTM C207-91, Type S hydrated.

C. Aggregates:

1. Mortar: ASTM C144-89, sand.
2. Grout: ASTM C404-87.

D. Water: Fresh, clean, potable.

E. Mortar Plasticizer Admixture: American Colloid Co.; Easy/Spred Plasticizer.

F. Mortar Pigment: Inert coloring pigments. Color to be selected by RESIDENT ENGINEER.

2.3 REINFORCEMENT

A. Deformed Bars: As specified in Section 03210, REINFORCING STEEL.

2.4 PREFORMED CONTROL JOINTS

A. Solid rubber extrusions as manufactured by:

1. Dur-O-Wall National Co., Cedar Rapids, IA; Regular Rapid Control Joint.
2. Sonneborn-Contech Co., Oakland, CA; Sonneborn Control Joint.

2.5 MORTAR MIXES

A. Proportions:

1. In accordance with ASTM C270-89, Type S.
2. Mortar plasticizer admixture may be substituted for lime. Batch in accordance with ICBO, Current Reports for the specified mortar type and strength.

B. Mixing:

1. Machine mix in approved mixers.
2. Keep mixer drums clean and free of debris and dried mortar.
3. Mix by placing 1/2 water and 1/2 aggregate in operating mixer.
4. Add cement.
5. Add remaining aggregate and water and mix for at least 2 minutes.
6. Add lime and continue mixing as long as needed to secure a uniform mass, but no less than 3 minutes after addition of lime.
7. Time addition of admixture in accordance with manufacturer's instructions. Procedure used for adding it to mix shall provide good dispersion.
8. Follow manufacturer's instructions for mortar plasticizer admixture.

C. Where colored masonry units are used, color mortar to match. Inert coloring pigments may be added but shall not exceed 6 percent by weight of cement.

2.6 GROUT MIXES

A. Proportions: Conform to ASTM C476-83 for coarse grout except as follows:

1. For Pouring:
   a. Fluid consistency (suitable for pouring without segregation) meeting requirements of ASTM C476-83.
   b. Conform to Uniform Building Code, Table No. 24-G.
2. For Pumping: Fluid consistency with minimum seven sacks of cement in each cubic yard.
3. Compressive Strength: Minimum 2,000 psi average at 28 days.

B. Mixing:

1. Onsite: Follow procedure specified in Article MORTAR.
2. Transit-Mixed Grout: Meet requirements of ASTM C476-83.
3. Add approved grout admixture in accordance with specified grout admixture manufacturer's recommendations, premix admixture with water and add resulting solution to grout mix and thoroughly mix. Do not exceed quantity of admixture recommended by manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

A. Prepare surface contact area on foundation concrete for initial mortar placement by one of following methods:

1. Sandblasting foundation and reinforcing dowels after concrete has fully cured to remove laitance and spillage and to expose sound aggregate.
2. Water blasting foundation and reinforcing dowels after concrete has partially cured to remove laitance and spillage and to expose sound aggregate.
3. Green cutting fresh concrete with high pressure water and hand tools to remove laitance and spillage from foundation and reinforcing dowels and to expose sound aggregate.

B. Clean surfaces of loose material prior to initial mortar placement.

C. Prevent surface damage to foundation concrete that will be exposed to view outside of contact area.

3.2 LAYING REINFORCED MASONRY UNITS

A. General:

1. Conform to the Building Code applicable to this Project as supplemented by these Specifications.
2. Do not start laying masonry units unless foundation wall is plumb within 1/4 inch in 10 feet or not straight within 5/16 inch in 10 feet.
3. Finish Tolerances (Measured on Interior Surfaces):
   a. Maximum Permissible Variation From Plumb of Masonry Wall or of Line of Joints in Masonry Wall: 1/16 inch per foot of height, and 1/4 inch in the total height of the wall.
   b. Maximum Permissible Variation From Horizontal Line Along Base of Wall or for Lines of Horizontal Joints: 1/16 inch per block, 1/4 inch per 50 feet of wall with proportionately greater tolerance for longer walls up to 1/2 inch in total length of wall.
4. Place units with chipped edges or corners within permissible ASTM limits in wall such that chipped area is not exposed to view.

B. Wall Units:

1. General:
   a. If necessary to move a unit after once set in place, remove from wall, clean, and set in fresh mortar.
   b. Toothing of masonry units is not permitted.
2. Running Bond:
   a. Unless otherwise shown, lay up walls in straight, level, uniform courses using a running bond pattern.
   b. Place units for continuous vertical cells and mortar joints to prevent materials such as grout or poured insulation from escaping from cell being filled to adjacent cells where material is not intended to be placed.
3. Corners: Lay standard masonry bond for overlapping units and grout solid.
4. Intersecting Walls: Bond with reinforcement, not with masonry bond.

C. Special Shapes:

1. Provide and place such special units as corner block, door jamb block, lintel block fillers, and similar blocks as may be required.
2. Use required shapes and sizes to work to corners and openings, maintaining proper bond throughout wall.

3.3 BUILT-IN ITEMS

A. Position door frames, windows, vents, louvers, and other items to be built in the wall, and construct wall around them.

B. Install masonry anchors to secure items to wall.

C. Fill spaces around items with mortar or grout.

D. Do not place electrical, instrumentation, or water conduits in a cell containing reinforcement unless approved in writing by RESIDENT ENGINEER.

3.4 MORTAR JOINTS

A. General:

1. Straight, clean, with uniform thickness of 3/8 inch.
2. Horizontal and vertical mortar joints shall have full mortar coverage on face shells.
3. Vertical Head Joints:
   a. Butter well on each unit for a width equal to face shell of unit, shove tightly so mortar bonds well to both units.
   b. Solidly fill joints from face of block to at least the depth of face shell.
4. As units are laid, remove excess mortar from grout space of cells to be filled.
5. Place mortar before initial setting of cement takes place. Do not retemper mortar that has started to set.

B. Exposed Joints:

1. Tool joints exposed to view after final construction, unless otherwise noted or shown. Raked joints shall have square faces 3/8-inch deep.
2. Cut joints flush and, as mortar takes its initial set, tool to provide a concave joint.
3. Perform tooling when mortar is partially set but still sufficiently plastic to bond.
4. Perform tooling with a tool which compacts mortar, pressing excess mortar out rather than dragging it out.
5. Rake out joints which are not tight at time of tooling, point, and then tool.
6. Rake and tool joints at split-face surfaces, interior and exterior.

C. Concealed Joints: Strike flush with no further treatment required.

3.5 CONTROL JOINTS

A. Preformed Control Joints:

1. Omit mortar from vertical joints.
2. Place rubber control joint material as wall is built.
3. After wall is grouted, cured, and cleaned, install backing rod and sealant as specified in Section 07900, JOINT SEALANTS.
4. Place and tool sealant to match depth of typical joint.

3.6 REINFORCING

A. Foundation Dowels:

1. Size, number, and location of foundation dowels shall match vertical wall reinforcing, unless otherwise noted.

2. When foundation dowel does not line up as intended, with vertical core, do not slope more than 1 horizontal to 6 vertical to bring it into alignment.

B. Vertical Reinforcing:

1. Use deformed bars.
2. Hold in position near the ends of bars by wire ties to dowels or by reinforcing positioners.
3. Hold in position at maximum intervals of 160 bar-diameters by reinforcing positioners.

C. Horizontal Reinforcing:

1. Use deformed bars.
2. Lay on webs of bond beam units, and place as wall is built.
3. Lap reinforcing bars 48 bar-diameters minimum where spliced and wire tie together.
4. Minimum Bar Clearance: 1 bar-diameter from masonry and from additional parallel bars in same grout space.

3.7 GROUTING

A. General:

1. Do not mix, convey, or place with equipment constructed of aluminum.
2. Secure vertical and horizontal reinforcement, ties, bolts, anchors, and other required embedments in place, inspect and verify before placing grout.
3. Grout beams over openings in one continuous operation.
4. Maintain vertical alignment in cells to provide a clear, unobstructed, continuous vertical cell measuring not less than 2 inches by 3 inches.
5. Place grout as soon as possible after mortar has set to reduce shrinkage cracking of vertical joints.
6. Vertical Reinforcement:
   a. First wire tie to foundation dowels, then build wall around it.
   b. Provide reinforcing positioners or approved cross-bracing to secure top of steel in place.
   c. Do not drop in vertical steel after block is laid unless reinforcing positioners are provided in the course above previously grouted course.

B. Grouting Requirements:

1. Solid Grouting Requirements: Space vertical grout barriers maximum 30 feet apart, extending full height of wall.
2. Partial Grouting Requirements:
   a. Walls Not Requiring Solid Grouting: Fill cells containing reinforcing steel and others as shown with grout.
   b. Construct cells to be filled to confine grout within cell.
   c. Cover tops of unfilled vertical cells under a bond beam with metal lath to confine grout fill to bond beam section.

3. Form horizontal construction joints between pours by stopping the grout pour 1-1/2 inches below a mortar joint except at a bond beam, stop the pour 1/2 inch below the top of the masonry unit.
4. Place grout in lifts not to exceed 6 feet in height.
5. Fully embed horizontal steel by grout in an uninterrupted pour.
6. Do not construct wall more than one course above top of grout pour prior to placing grout.
7. Vibration:
   a. Use internal "pencil" type vibrator to thoroughly consolidate grout and reduce amount of air voids.
   b. After waiting sufficient time to permit the grout to become plastic, but before it has taken any set, reconsolidate grout.
   c. Waiting period will vary depending upon weather conditions and block absorption rates, but under "normal" weather conditions with average masonry units the waiting period should be between 30 to 60 minutes.
8. Cleanouts:
   a. Provide of sufficient size to permit cleaning of cell, positioning of reinforcing and inspection at bottom of every vertical cell containing reinforcing.
   b. Location: Concealed from view after final construction unless otherwise approved by RESIDENT ENGINEER.
   c. After wall has been inspected and approved and prior to grouting, cap cleanouts in a manner that will seal them from grout leakage and provide a flush finish.

3.8 SANDBLASTING

A. All exterior masonry surfaces shall be brush-blasted.

B. Techniques and equipment shall be used to obtain texture as applied to the mock-up panels and approved by RESIDENT ENGINEER.

3.9 FIELD QUALITY CONTROL

A. Provide adequate facilities for safe storage and proper curing of mortar and grout samples onsite for first 24 hours, and for additional time as may be required before transporting to test lab.

B. Provide masonry units for test samples required by ASTM C140-91.

C. Sample grout and mortar for strength testing at beginning of masonry work and at least once a day thereafter.

1. Field Compressive Test for Grout:
   a. Sample and test in accordance with UBC Standard 24-28.
   b. On a flat nonabsorbent base, form a space approximately 3 inches by 3 inches by 6 inches high, twice as high as it is wide, using masonry units having the same moisture conditions as those being laid.
   c. Line space with permeable paper or porous separator so water may pass through liner into masonry units.

d. Thoroughly mix or agitate grout to obtain a fully representative mix, place into molds in two layers, and puddle each layer with a 1-inch by 2-inch puddling stick to eliminate air bubbles.
e. Level off and immediately cover molds and keep them damp until taken to the laboratory.
f. After 48 hours set, carefully remove masonry units and transport and place grout Samples in a fog room until tested.

2. Field Compressive Test for Mortar:
   a. Sample mortar for test in accordance with UBC Standard 24-22 and applicable portions of 24-26.
   b. Spread mortar on masonry units 1/2-inch to 5/8-inch thick, allow to stand for 1 minute, then remove mortar and place in a 2-inch by 4-inch cylinder in two layers, compressing mortar into cylinder using flat end stick or fingers.
   c. Lightly tap mold on opposite sides, level off and immediately cover molds and keep them damp until taken to the laboratory.
   d. After 48 hours set, remove molds and place them in a fog room until tested in damp condition.

3.10 CLEANING

A. Immediately after completion of grouting, clean masonry surfaces, using clean water and fiber brushes, of excess mortar, grout spillage, scum, stains, dirt, and other foreign substances.

B. Clean walls not requiring painting or sealing such that there are no visible stains.

3.11 PROTECTION OF INSTALLED WORK

A. Do not allow grout and mortar stains to dry on face of exposed masonry.

B. When moisture protection is required, use light fog spray nozzles to cure mortar.

C. Protect tops of walls at all times. Cover tops of walls with waterproof paper when rain is imminent and when Work is discontinued.

D. Adequately brace walls until walls and roof are completed.

E. Provide sufficient bracing to protect walls against damage from elements, including wind and earthquake.

F. Protect masonry against freezing for minimum 72 hours after being laid.

G. Protect masonry from damage until final acceptance of Work. Damaged units will not be accepted.

END OF SECTION

SECTION 05120
STRUCTURAL STEEL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work necessary to furnish, fabricate, assemble, deliver, and store coffer dam piles and panels.

B. Work necessary to furnish, fabricate, deliver, and erect structural steel for building framing elements.

1.2 SUBMITTALS

A. Shop Drawings:

1. Meet requirements of AISC.
2. Provide details showing:
   a. Members and their connections.
   b. Anchor bolt layouts.
   c. Hardened washer details.
   d. Schedules for fabrication procedures.
3. Name and address of manufacturer(s).
4. Product specifications.

B. Quality Control Submittals:

1. Welder Certifications:
   a. Submit for shop and field welders.
   b. Issued by recognized testing laboratory.
2. Weld Inspection Test Reports: Submit for review prior to completion of Work.
3. High-Strength Connection Bolts (Galvanized and Nongalvanized):
   a. Certificates of Compliance that products meet chemical and mechanical requirements of standards specified.
   b. Manufacturer's inspection test report results for production lot(s) furnished, to include:
      1) Tensile strength.
      2) Yield strength.
      3) Reduction of area.
      4) Elongation and hardness.
   c. Certified Mill Test Reports for Bolts and Nuts:
      1) Name and address of manufacturer.
      2) Bolts correctly marked.
      3) Marked bolts and nuts used in required mill tests and manufacturer's inspection tests.
4. Mill Certificates.
5. Methods proposed to resolve misalignment between anchor bolts and bolt holes in steel members.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Welders: Meet requirements of AWS D1.1-96 for procedures and qualifications of welders.

B. Regulatory Requirements: Comply with current provisions, except as otherwise indicated:

1. AISC "Code of Standard Practice for Steel Buildings and Bridges".
2. AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings" and including "Commentary of the AISC Specification".
3. AISC "Specifications for Structural Joints Using ASTM A325-93 or ASTM A490-93 Bolts" approved by Research Council on Structural Connections of the Engineering Foundation, November 13, 1985; endorsed by American Institute of Steel Construction and Industrial Fasteners Institute.
4. AWS Structural Welding Code AWS D1.1-96 and "Standard Qualification Procedure".
5. Manual of Steel Construction, American Institute of Steel Construction, Inc.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Load structural members in such a manner that they will be transported and unloaded without damage to coatings and without being excessively stressed, deformed, or otherwise damaged.
2. Transport and unload cofferdam piles and steel panels to a storage location in the City of Tempe designated by OWNER.

B. Storage:

1. Protect structural steel members and packaged materials from corrosion and deterioration.
2. Store in dry area and not in direct contact with ground.

C. Handle materials to avoid distortion or damage to members or supporting structures.

PART 2 PRODUCTS

2.1 MATERIALS

A. Rolled Plates, Shapes, and Bars: ASTM A36-93a unless otherwise shown.

B. Structural Steel Pipe: ASTM A501-93, or ASTM A53-93a, Type E or S, Grade B.

C. Structural Tubing: ASTM A500-93, Grade B (fy equals 46 ksi); provide full length members without splices unless otherwise noted or approved.

2.2 FASTENERS

A. Anchor Bolts: As specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

B. High-Strength Connection Bolts: ASTM A325-93 or ASTM A490-93, Type 3 bolts, with the length required when hardened washers are used.

C. Hardened Washers: ASTM F436-93, type to match bolt type and finish.

D. Welded Anchor Studs: Furnish headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded anchor studs (TAS) as shown.

1. Manufacturer: Nelson Stud Welding Co., Loraine, OH.

2.3 ANCILLARY MATERIALS

A. Surface Preparation, Primer, and Enamel: As specified in Section 09900, PAINTING.

B. Grout: As specified in Section 03600, GROUT.

C. Coffer dam rubber seals and connection hardware shall be as specified in Section 05500, METAL FABRICATION AND CASTINGS.

2.4 FABRICATION

A. General:

1. Fabricate as shown on Drawings and in accordance with AISC Specifications, CONTRACTOR's erection requirements, and approved Shop Drawings.
2. Mark and match mark materials for field assembly.
3. Complete assembly, including bolting and welding of units, before start of finishing operations.
4. Fabricate to agree with field measurements.

B. Connections:

1. Shop Connections: Weld or bolt, as shown.
2. Develop full strength of members joined and meet requirements of AISC Standard Connections, unless otherwise shown.

C. Welded Construction: Comply with AWS D1.1-96 for procedures, appearance, and quality of welds, and methods used in correcting welding Work.

1. Butt Welds: Complete penetration unless otherwise specified.

D. Interface With Other Work:

1. Holes: As necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members.
   a. No torch cut holes are permitted.
2. Weld threaded nuts to framing, and other specialty items as shown to receive other Work.

E. Shop Paint Primer:

1. Surface Preparation: Clean and remove slag from welds before painting.
2. Coat members with primer except at future field welds, bolt-ups, and concrete embedment.
3. Apply primer in accordance with Section 09900, PAINTING, within 8 hours after surface preparation.

2.5 SOURCE QUALITY CONTROL

A. Shop Inspection:

1. RESIDENT ENGINEER may inspect fabrication and shop assembly of members and high-strength bolted and welded connections, to perform tests and prepare test reports.
2. Furnish facilities for inspection of materials and workmanship. Provide RESIDENT ENGINEER with unlimited access to the Work.

PART 3 EXECUTION

3.1 ERECTION

A. Install CONTRACTOR designed temporary construction bracing to provide necessary support until all components are in place and construction is complete.

B. Sequence erection.

C. Meet requirements of AISC Specifications and Code of Standard Practice.

D. Hardened Washers:

1. Provide at locations required by Washer Requirements section of AISC Specification for Structural Joints using ASTM A325-90 or ASTM A490-90 Bolts.
2. Install under turned element (bolt head or nut) and between turned element and indicator washer protrusions.

E. High-Strength Connection Bolts: Use ASTM A325-90 bolts unless otherwise shown.

3.2 ANCHOR BOLTS

A. Coordinate installation of Anchor Bolts and other connectors required for securing structural steel to in-place work.

B. Provide templates and other devices for presetting bolts and other anchors to accurate locations.

3.3 SETTING BASES AND BEARING PLATES

A. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to surfaces.

B. Clean bottom surface of base and bearing plates.

C. Set loose and attached baseplates and bearing plates for structural members on wedges, leveling nuts, or other adjustable devices.

D. Tighten anchor bolts after supported members have been positioned and plumbed.

E. Grout Under Baseplates: As specified in Section 03600, GROUT, prior to placing loads on structure.

3.4 FIELD ASSEMBLY

A. Set structural frames accurately to lines and elevations shown.

B. Align and adjust various members forming a part of a complete frame or structure before permanently fastening.

C. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly.

D. Perform necessary adjustments to compensate for minor discrepancies in elevations and alignment.

E. Level and plumb individual members of structure within AISC tolerances.

F. Establish required leveling and plumbing measurements on mean operating temperature of structure.

G. Bolt field connections except where welded or other connections are shown.

3.5 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in erection bolting are encountered, immediately notify RESIDENT ENGINEER for selection of industry standard remedy method:

1. Ream holes that must be enlarged to admit bolts and use oversized bolts.

2. Plug weld misaligned holes and redrill holes to admit standard size bolts.
3. Drill additional holes in the connection, conforming with AISC Standards for bolt spacing and end and edge distances, and add additional bolts.
4. Reject member containing misfit, incorrect sized, or misaligned holes and fabricate a new member to ensure proper fit.

B. Do not enlarge incorrect sized or misaligned holes in members by burning or by use of drift pins.

3.6 MISFITS AT ANCHOR BOLTS

A. Resolve misalignments between anchor bolts and bolt holes in steel members in accordance with approved submittal.

B. Do not flame cut to enlarge holes.

3.7 GAS CUTTING

A. Do not use gas cutting torches in field for correcting fabrication errors in structural framing.

1. Secondary members not under stress and concealed in finished structure may be corrected by gas cutting torches, if approved by RESIDENT ENGINEER.

B. Finish gas-cut sections equivalent to sheared appearance.

3.8 PAINTING

A. Touchup:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of slag and shop paint primer.
2. Apply touchup paint primer by brush or spray of same thickness and material as that used in shop application.
3. Coffer dam piles and panels shall be painted after fabrication and assembly in accordance with System No. 5 as specified in Section 09900, PAINTING.

END OF SECTION

SECTION 05310
STEEL DECK

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Plan view layout of decking.
2. Location of openings, deck laps, and welds.

B. Quality Control Submittals:

1. Decking manufacturer's installation recommendations.
2. Welding procedures and welder qualification records using forms provided in Appendix A to AWS D1.3-89.
3. Welding inspector's qualifications.
4. Certificate of Compliance.
5. Welding inspection report.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Qualify welders and welding procedures to meet requirements of latest edition of AWS D1.3-89.
2. Welding Inspector: Certified CWI in accordance with requirements of AWS QC-1-88.

B. Regulatory Requirements: For metal decking section properties, meet requirements of AISC Specifications for Design of Cold-Formed Steel Structural Members.

PART 2 PRODUCTS

2.1 METAL DECKING

A. Depth, gauge, type, section modulus, moment of inertia, and allowable diaphragm shear as shown.

B. Furnish manufacturer's standard closure plates, fasteners, and accessories.

C. Fabrication:

1. Coat steel with zinc protective coating meeting requirements of ASTM A525-91b light commercial coating, G60 applied prior to forming.
2. Form steel decking from steel sheets meeting ASTM A446-91, ASTM A570-92, or ASTM A611-92.

D. Manufacturers:

1. H. H. Robertson Co.
2. Vulcraft Division of Nucor Co., Brigham City, UT.
3. ASC Pacific, Inc., Sacramento, CA.
4. Verco Manufacturing, Inc., Phoenix, AZ.

2.2 SHOP PAINT PRIMER

A. Clean and coat with shop paint primer where shown in Finish Schedule.

B. Surface Preparation and Primer: As specified in Section 09900, PAINTING, System No. 107.

C. Remove all slag from welds before painting.

D. Apply shop paint prime coat within 8 hours after surface preparation.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install at right angles to supporting members, unless shown otherwise and in accordance with manufacturer's installation recommendation.

B. Cut and fit around roof openings.

C. Extend sheets over a minimum of three spans.

D. Bearing: 2 inches minimum.

E. Endlaps: Minimum of 3 inches and located over supports.

F. Do not stretch sidelaps.

G. Install closure plates and accessories.

H. Finished Metal Decking: Free from buckles and irregularities.

I. Weld panels to perpendicular supports with following minimum number of welds, unless shown otherwise on Drawings.

Panel Width	No. of Welds
36 inches	5
30 inches	4

J. Weld panels to parallel supports with welds at 12 inches on center, unless otherwise shown.

K. Panel sidelaps shall be fastened/interconnected at 12 inches on center, unless otherwise shown.

L. Welds to supports shall be with 5/8-inch effective diameter arc spot (puddle) welds.

M. Welds at panel ends shall be 1-1/8 inches from centerline of weld to edge of panel.

N. Nested sidelaps shall be fastened/interconnected using No. 10 Buildex Teks screws, unless otherwise shown.

O. Completed Deck: Welded steel diaphragm.

3.2 PAINTING

A. Touchup:

1. Immediately following erection, clean field welds, bolted connections, and abraded areas.
2. Apply touchup paint primer by brush or spray of same thickness and material as that used for shop paint.
3. Repair damaged galvanized surfaces as specified in Section 09900, PAINTING, System No. 11.

3.3 FIELD QUALITY CONTROL

A. Welding Inspector:

1. Present on Work site full time.
2. Duties to include, but not be limited to the following:
   a. Project material verification and storage.
   b. Qualification of welders and welding procedures.
   c. Verification of approved welding procedures.
   d. Maintaining records and preparing reports.
   e. Rod control procedures.

END OF SECTION

SECTION 05410
METAL FRAMING SYSTEMS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Plan view layout of stud walls, joists, and joist bracing.
2. Member sizes.
3. Details of track, web stiffeners, stud bracing, and other members as required to provide a complete installation.
4. Location of openings and framing details.
5. Detail of connections including welding, fastenings, and ancillary items.
6. Material, specifications, and descriptive literature.
7. Installation or erection instructions, including sequence of operations and requirements for temporary bracing.

B. Quality Control Submittals:

1. Qualifications: Welder qualification records using forms provided in appendix to AWS D1.3-89 welding code.
2. Welding procedures.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Welders and Welding Procedures: Meet requirements of AWS D1.3-89.
2. Contractor's Welding Inspector: Qualified in accordance with requirements of AWS QC 1-88.

B. Regulatory Requirements: Meet requirements of the Uniform Building Code.

PART 2 PRODUCTS

2.1 MATERIALS

A. General:

1. Conform to the requirements of AISI Specification for the Design of Cold-Formed Steel Structural Members.
2. Structural Framing Members (Studs, Joists, Bridging, and Nonload Bearing Studs) and Accessories: Products of the same manufacturer.
3. 20-Gauge and Heavier Components: Minimum G-60 galvanized coating, meeting ASTM A525-91b and C955-92.

4. At CONTRACTOR's option, studs and furring may be of the nailable type.
5. Section Properties: Computation of section properties in conformance with the American Iron and Steel Institute Manual "Specifications and Design of Cold-Formed Steel Structural Members."

B. Manufacturers:

1. Dale Industries; Dale/Incor Steel Framing.
2. Gold Bond Building Products; Light Gauge Steel Framing Systems.
3. Marino Industries Corp.; Stud-rite Lightweight Steel Framing.
4. Unimast Inc.; Steel Framing Systems.

C. Studs, Tracks, and Joists: ASTM C955-92.

Member Properties					
Use	**Type**	**Size**	**Area**	**Ix**	**Rx**
Studs & Joists	Punched	4"	0.5390	1.319	1.564

D. Accessories: Furnish fasteners, bridging, bracing, web stiffeners, and clips as required for a complete installation.

1. Top and Bottom Runner Tracks: Size required to fit over studs or furring, the same gauge and unpunched.
2. Blocking Braces and Fire Stops: Same depth as studs or furring, 16-gauge and unpunched.
3. Mounting Plates: ASTM A446-91, Grade A, sheet steel, minimum 0.060-inch thick by 8 inches by 18 inches.

PART 3 EXECUTION

3.1 PREPARATION

A. Provide complete uniform and level bearing support for the bottom track.

B. Clean surfaces that will be in contact after assembly.

3.2 INSTALLATION

A. Install complete framing and furring systems in accordance with manufacturer's recommendations.

B. Fasten framing members together in accordance with AISI SG-787-80.

C. Provide steel tracks and other metal framing components required for a complete installation.

D. Attach components by welding. Attach studs to steel tube frame and angle support brackets by welding. Wire tying of framing components in structural application is not permitted.

E. Cut steel framing with a saw or shear. Torch cutting of load bearing members is not permitted.

F. Install axially loaded studs so that the ends of the studs are positioned against the inside track web, prior to stud and track attachment.

G. For welding, use a fusion welding machine of dc (straight polarity) or ac (Buzz Box type) current or 200 amperes capacity or less, with a welding heat of 60 to 110 amperes (depending on gauge of material and fit of parts) with an AWS Electrode Classification E60.

H. Do not use gas cutting for field correction of fabrication unless approved by RESIDENT ENGINEER.

I. Holes that are field cut into steel framing members shall be within limitations of the product and its design. Provide reinforcement where holes are cut through load bearing members in accordance with manufacturer's recommendations and as approved by RESIDENT ENGINEER.

J. Restoration of Galvanizing: After erection, fully restore damaged galvanized surfaces.

K. Tolerances:

1. Vertical Alignment (Plumbness) of Studs: Within 1/960th (1/8 inch in 10 feet 0 inch) of the span.
2. Horizontal Alignment (Levelness) of Walls: Within 1/960th (1/8 inch in 10 feet 0 inch) of their respective lengths.
3. Stud Spacing: Not more than plus or minus 1/8 inch from the designed spacing providing that the cumulative error does not exceed the requirements of the finishing materials.

3.3 ASSEMBLY AND ERECTION

A. Install framing in true line, plumb, level, and in proper alignment.

B. Cut framing components squarely or on an angle to fit squarely against abutting members. Hold members firmly in position until properly fastened.

C. Attach bottom runner tracks with suitable fasteners located 2 inches from each end and spaced not more than 24 inches on center. Attach continuous top track securely to the overhead member.

D. Attach studs to structural tube steel frame and support angles.

E. Seat studs squarely in the track with the stud web and flanges abutting the track web, plumbed or aligned, and securely attached to the flanges or web of both the upper and lower tracks.

F. Use butt welds or splices at butt joints in the track.

G. No splices permitted in axial loaded studs. Use fillet, plug, butt, or seam welds. Field welding shall be in accordance with manufacturer's recommendations to avoid damage to studs.

H. Framed wall openings include headers and supporting studs.

I. Frame walls and partitions shall have double studs at openings and triple studs at corners. Arrange plates to form continuous horizontal ties, welding splices.

J. Provide blocking for support of mechanical items.

K. Attach wall stud bridging in a manner to provide resistance to both minor axis bending and rotation. Space bridging rows not to exceed 4 feet on center for axially loaded walls.

L. Use unpunched track for end closures at walls, eaves, and fascias.

M. Fire stop stud walls and partitions with unpunched blocking full width of stud at midpoint or where required for nailers and in conformance with the applicable building code.

END OF SECTION

SECTION 05500
METAL FABRICATIONS AND CASTINGS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Metal fabrications, including welding and fastener information.
2. Specific instructions for all phases of installation including hole size, preparation, placement, procedures, and instructions for safe handling of anchoring systems.
3. Wrought iron security fencing and gates at dam abutments showing all anchorage, connection details, and gate hardware.

B. Samples:

1. Epoxy Anchors: Two self-contained epoxy adhesive cartridges for each batch of epoxy delivered to site, for independent testing.
2. Vinyl Ester Anchors: Two self-contained adhesive cartridges for each batch of adhesive delivered to site, for independent testing.

C. Quality Control Submittals:

1. Vinyl Ester and Epoxy Anchors:
   a. Manufacturer's Certificate of Compliance.
   b. Manufacturer's past project experience data.
   c. Test reports for each batch of vinyl ester or epoxy delivered to site.
   d. Manufacturer's Certificate of Qualification for installers.
   e. Current design load test data.
2. Welders: Evidence of certification.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Welders: Certified in accordance with AWS D1.1-96, Chapter 5.
2. Vinyl Ester and Epoxy Anchor Manufacturers: Experience on at least three similar projects within the last 3 years.
3. Vinyl Ester and Epoxy Anchor Installers: Trained and certified by manufacturer.

B. Regulatory Requirements:

1. Anchoring Systems: Current evaluation and acceptance reports by ICBO.

C. Welding Procedures: Follow the requirements of AWS D1.1-96 and AWS D1.2-90.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipment:

1. Insofar as practical, factory assemble items specified herein.
2. Package and clearly tag parts and assemblies that are of necessity shipped unassembled, in a manner that will protect materials from damage, and facilitate identification and field assembly.

B. Storage of Epoxy Adhesive:

1. Store epoxy cartridges on pallets or shelving in a covered storage area.
2. Control temperature above 60 degrees F and dispose of cartridges if shelf life has expired.

C. Storage of Vinyl Ester Products:

1. Store components on pallets or shelving in a covered storage area with locking door.
2. Control temperature within 41 to 77 degrees F and dispose of product if shelf life has expired.

PART 2 PRODUCTS

2.1 MATERIALS

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Specification
Steel Shapes and Plates	A36-91
Steel Pipe	A501-89 or A53-90b, Type E or S, Grade B
Structural Steel Tubing	A500-90a, Grade B
Stainless Steel:	
Bars and Shapes	A276-92, AISI Type 316
Steel Plate, Sheet, and Strip	A167-92b, AISI Type 316
Bolts and Threaded Rods	A193-92, AISI Type 316, B8MN, B8M2, or B8M3
Nuts	A194-92a, AISI Type 316, B8MN, B8M2, or B8M3
Steel Bolts and Nuts:	
Carbon Steel	A307-92a or A36-90

Item	ASTM Specification
High-Strength	A325-92a, Type 3
Galvanized Steel Bolts and Nuts	A307-92a or A36-91, with A153-82 Zinc Coating, and ANSI B1.1-89
Eyebolts	A489-90
Threaded Rods	A36-91
Flat Washers (Unhardened)	F844-90; use A153-82 for Zinc Coating
Flat Washers (Hardened)	F436-92
Aluminum, Structural Shapes, and Plates	B209-92a and B308-92a, Alloy 6061-T6
Aluminum Bolts and Nuts	F468-90b, Alloy 2024-T4
Cast Iron	A48-92, Class 35

B. Checkered Plates:

1. Steel: Federal Specification QQ-F-461, Class I, minimum 1/4 inch; galvanize after fabrication.
2. Aluminum: ASTM B209-92a, Alloy 6061-T6, tread plate, thickness minimum 1/4 inch.

C. Anchor Bolts: As shown in FASTENER SCHEDULE at the end of this section and as specified in various equipment sections.

D. Anchor Bolt Sleeves:

1. High Density Polyethylene Plastic:
   a. Single unit construction with deformed sidewalls such that the concrete and grout lock in place.
   b. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor bolt projection.
   c. Material requirements:
      1) Plastic: High density polyethylene.
      2) Density: ASTM D1505-90.
      3) Vicat Softening Point: ASTM D1525-91.
      4) Brittleness Temperature: ASTM D746-79 (1987).
   d. Manufacturer: Sinco West, Simi Valley, CA.
2. Fabricated Steel Sleeve: A36-91 steel.

E. Antiseizing Lubricant: Lubricant shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper. Use Loc Tite Co., Permatex.

F. Neoprene Gasket and Cofferdam Seals:

1. ASTM D1056-91 RE-41-E, soft, closed-cell, neoprene gasket material, unless otherwise shown.
2. Thickness: Minimum 1/4 inch.
3. Furnish without skin coat.
4. Manufacturers and Product:
   a. Rubatex Division of Great American Industries, Bedford, VA; Rubatex No. R-411-N.
   b. Garlock Manufacturing, San Francisco, CA.

G. Pipe Sleeves: ASTM A53-90b, Schedule 40 steel pipe sleeves with continuously welded 3/16-inch thick seep ring of outside diameter 3 inches greater than sleeve outside diameter. Galvanize in accordance with ASTM A123-89a.

2.2 ANCHORING SYSTEMS FOR CURED CONCRETE

A. Wedge Anchors:

1. AISI Type 316 stainless steel throughout.
2. Manufacturers and Products:
   a. ITW Ramset/Red Head, Wood Dale, IL 60191; Trubolt Wedge Anchor.
   b. Hilti, Inc., Tulsa, OK 74121; Kwik-Bolt II Stud Anchor.
   c. Wej-It Corp., Tulsa, OK 74152; Wej-It Anchor Bolt.
   d. The Rawl Plug Co., New Rochele, NY 10802; Rawl Stud Anchor.

B. Expansion Anchors:

1. Self-drilling anchors, snap-off type or flush type.
2. Furnish anchors for use with galvanized bolts.
3. Nondrilling Anchors: Flush type for use with bolt, or stud type with projecting threaded stud.
4. Manufacturers and Product:
   a. ITW Ramset/Red Head, Wood Dale, IL 60191; Multi-Set II Drop-In and Self-Drill Anchors.
   b. Hilti, Inc., Tulsa, OK 74121; Hilti HDI Drop-In Anchor.
   c. The Rawl Plug Co., New Rochele, NY 10802; Rawl Steel Drop-In and Rawl Saber Tooth Anchors.

C. Epoxy Anchors:

1. Anchor Rod: Stainless steel threaded rod free of grease, oil, or other deleterious material with a 45-degree chisel point.
2. Epoxy Adhesive:
   a. ASTM C881-90, Type 1, Grade 3, Class A, B, or C.
   b. Two-component, 100 percent solids, nonsag, paste, insensitive to moisture, designed to be used in adverse environments and gray in color.

c. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.

3. Mixed Epoxy Adhesive: Nonsag paste consistency, with ability to remain in a 1-inch diameter overhead drilled hole without runout, having the following properties:
   a. Slant Shear Strength, ASTM C881-90, No Failure In Bond Line, Dry/Moist Conditions: 5,000 psi.
   b. Compressive Strength, ASTM D695-91: 14,000 psi, minimum.
   c. Tensile Strength, ASTM D695-91: 4,500 psi.
   d. Heat Deflection Temperature, ASTM D648 E2-82: 135 degrees F, minimum.
4. Epoxy Adhesive Packaging:
   a. Disposable, self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio, and fit into a manually or pneumatically operated caulking gun.
   b. Cartridge Markings: Include manufacturer's name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
5. Manufacturers and Products:
   a. Adhesives Technology Corp., Kent, WA 98031; Anchor-It Fastening Systems, HS 200 Epoxy Resin.
   b. ITW Ramset/Red Head, Wood Dale, IL 60191; Epcon Ceramic 6 Epoxy Anchor System.
   c. Covert Operations, Long Beach, CA 90853; CIA Epoxy Anchors with viscosity to suit application.
   d. Rawl Plug Co., New Rochele, NY 10802; Rawl/Sika Foil Fast Epoxy Injection Gel System.

D. Adhesive Anchors:

1. Two-component vinyl ester adhesive, insensitive to moisture, designed to be installed in adverse environments.
2. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
3. Container Markings: Include manufacturer's name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
4. Anchor rods as shown.
5. Manufacturer and Product: Hilti, Inc., Tulsa, OK 74121; HIT Doweling Anchor System (HIT C-100).

2.3 FLAT BAR LADDERS

A. Material: Aluminum.

B. Punch rails, pass rungs through rails, and weld on outside.

C. Weld brackets to the ladder for fastening ladder to wall.

D. Ladder Safety Post: Equip ladders beneath sidewalk doors, roof hatches, skylights, or other floor or roof openings with telescoping tubular safety

post, spring balanced and automatically locking in the raised position, with release lever for unlocking.

1. Hot-dip galvanized post.
2. Spring Mechanism: Corrosion-resistant steel alloy.
3. Furnish dissimilar metal protective coatings at connections.
4. Manufacturer and Product: Bilco Co., New Haven, CT; "Ladder Up" to fit ladder rungs.

2.4 SAFETY CLIMB DEVICE

A. General:

1. Furnish complete Saf-T-Climb System.
2. Meet or exceed Federal Specification RR-S-001301 and OSHA Regulation No. 1910.27.
3. Belts and harnesses shall withstand a minimum drop test of 250 pounds in a 6-foot free fall.
4. Fall Prevention System Material: Aluminum 6061-T6.

B. Components and Accessories:

1. Main Components: Saf-T-Lock Sleeve, the Saf-T-Belt, and the Saf-T-Notch Carrier Rail.
2. Ladder rung clamps with aluminum mounting brackets and hardware.
3. Removable extension kit with tiedown rod, mandril, and carrier rail for ladders under manholes and hatches.
4. Furnish additional accessories required to complete the system for each ladder.
5. Furnish one harness for each ladder equipped with a safety climb device.
6. Furnish pivot section at platforms, landings, and roofs.

C. Manufacturer: North Consumer Products, Division of SIEBE North Inc., Brea, CA.

2.5 FABRICATION

A. General:

1. Finish exposed surfaces smooth, sharp, and to well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Material Thinner than 1/8 Inch: Either galvanize before fabrication in accordance with ASTM A525-91b, Coating Designation G210, or after fabrication in accordance with ASTM A123-89a, except the weight of zinc coating shall average minimum 1.2 ounces per square

foot of actual surface area with no individual specimen having a weight of less than 1 ounce per square foot.

B. Materials: Use steel shapes unless otherwise noted.

C. Fabrication:

1. Fit and assemble in largest practical sections for delivery to site.
2. Fabricate as shown on Drawings and in accordance with ASTM A385-80.
3. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
4. Use fasteners as shown or scheduled.
5. Grind cut edges smooth and straight.

D. Finish:

1. ASTM A123-89a hot-dip galvanize after fabrication, unless otherwise noted.
2. For items embedded in concrete, coat with System No. 2 as specified in Section 09900, PAINTING.
3. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.
4. Prepare galvanized surfaces to be painted in the field approximately 48 to 72 hours before painting as specified in Section 09900, PAINTING, System No. 10, Galvanized Metal Conditioning.
5. Completely seal edges of tightly contacting surfaces, where galvanizing is required, by welding before galvanizing.

E. Watertight: Where required or shown, furnish rubatex gaskets of a type that is satisfactory for use in contact with sewage. Cover full bearing surfaces.

F. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.

G. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

H. Aluminum:

1. Fabricate in accordance with the Aluminum Association Standards and manufacturers' recommendations as approved.
2. Grind smooth sheared edges exposed in finished work.

2.6 WELDING

A. Steel:

1. Meet requirements of AWS D1.1-92 for techniques of welding employed, appearance, quality of welds made, and the methods of correcting *defective* work.
2. Meet visual acceptance standards of AWS D1.1-92, paragraph 8.15.1.
3. Complete welding before applying finish.

B. Aluminum: Meet requirements of AWS D1.2.

2.7 ACCESS COVERS

A. Sidewalk Doors:

1. Exterior type waterproof aluminum single-leaf.
2. Component Fabrication:
   a. Access Door Leaf(s): 1/4-inch diamond pattern plate with reinforcing on underside to withstand live load of 300 pounds per square foot with maximum deflection of 1/150th of the span.
   b. Channel Frame: 1/4 inch with full anchor flange around perimeter.
   c. Equip door(s) with heavy stainless steel hinges with stainless steel pins.
   d. Hinges:
      1) Through-bolt to cover with tamper-proof stainless steel bolts or "lock bolts" to resist vandalism.
      2) Through-bolted to frame with stainless steel bolts and fiber locknuts.
   e. Equip doors with fully enclosed and lubricated compression springs with lower enclosing telescopic tube locked into supporting "boot" firmly attached to frame to retard downward motion of door leaves or corrosion-resistant stainless steel gas springs designed to limit to 17 pounds the lifting force required to open.
   f. Equip doors with hold-open arm with positive locking device with conveniently positioned release handle for easy and controlled closing.
   g. Furnish stainless steel snap lock mounted on bottom of leaf with removable topside handle and socket recessed in cover and provided with threaded plug for flush surface with handle removed.
   h. Locate 1-1/2-inch drainage coupling in front right corner of channel frame.
   i. Hardware: Type 304 stainless steel.
3. Aluminum Finish: Mill finish with bituminous coating applied to surfaces in contact with concrete.
4. Manufacturers:
   a. Bilco Co., New Haven, CT.
   b. Thompson Fabricating Co., Birmingham, AL.

PART 3 EXECUTION

3.1 INSTALLATION OF METAL FABRICATIONS

A. General:

1. Install metal fabrications plumb or level, accurately fitted, free from distortion or defects.
2. Install rigid, substantial, and neat in appearance.
3. Erect steel in accordance with applicable portions of AISC Code of Standard Practice, except as modified.
4. Install manufactured products in accordance with manufacturer's recommendations.
5. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
6. Field weld components indicated.
7. Perform field welding in accordance with AWS D1.1-92.
8. Obtain ENGINEER approval prior to site cutting or making adjustments not scheduled.
9. After erection, apply prime or galvanize coating to welds, abrasions, and surfaces not in contact with concrete.

B. Erection Tolerances:

1. Maximum Variation from Plumb: 1/4 inch per 10-foot story, noncumulative.
2. Maximum Offset from True Alignment: 1/4 inch.

C. Aluminum:

1. Erection: In accordance with the Aluminum Association specifications.
2. Do not remove mill markings from concealed surfaces.
3. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.

D. Pipe Sleeves:

1. Provide where pipes pass through concrete or masonry.
2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.
3. Provide a center flange for water stoppage on sleeves in exterior or water-bearing walls.
4. Provide a rubber caulking sealant or a modular mechanical unit to form a watertight seal in the annular space between pipes and sleeves.

3.2 ANCHOR BOLTS

A. Accurately locate and hold anchor bolts in place with templates at the time concrete is placed.

B. Use sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt. Minimum bolt size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

3.3 ANCHORING SYSTEMS FOR CONCRETE

A. Begin installation only after concrete or masonry receiving anchors have attained design strength.

B. Do not install an anchor closer than six times its diameter to either an edge of concrete or masonry, or to another anchor, unless specifically shown otherwise.

C. Install in accordance with manufacturer's specific quality control submittal instructions. Hole diameters are critical to installation, use only drills recommended by anchor manufacturer. Follow manufacturer's safe handling instructions.

D. Epoxy or Adhesive Anchors: Do not install when temperature of concrete is below 40 degrees F or above 100 degrees F, unless stated otherwise in manufacturer's written instructions.

E. Follow specific manufacturer safe handling practices when handling and installing concrete anchors.

3.4 ACCESS COVERS

A. Accurately position prior to placing concrete, such that covers are flush with floor surface.

B. Protect from damage resulting from concrete placement. Thoroughly clean exposed surfaces of concrete spillage to obtain a clean, uniform appearance.

C. Sidewalk Door:

1. Install in accordance with manufacturer's instructions.
2. Doors shall operate to satisfaction of ENGINEER.

3.5 ELECTROLYTIC PROTECTION

A. Aluminum:

1. Where in contact with dissimilar metals, or embedded in masonry or concrete, protect surfaces as specified in Section 09900, PAINTING, System No. 27.
2. Allow paint to dry before installation of the material.
3. Protect painted surfaces during installation.

4. Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.

B. Where titanium equipment is in contact with concrete or dissimilar metals, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70 durometer hardness.

3.6 MANUFACTURERS' SERVICES

A. Epoxy and Vinyl Ester Anchors: Conduct site training of installation personnel for safe and proper installation, handling, and storage of epoxy or vinyl ester adhesive system. Notify ENGINEER of time and place for sessions.

3.7 FASTENER SCHEDULE

A. Provide fasteners as follows:

Service Use and Location	Product	Remarks
Anchor Bolts Cast Into Concrete for Equipment Bases:		
All Areas	Stainless steel bolts, unless otherwise specified with equipment	
Submerged or Wet Areas	Stainless steel bolts with fusion bond coating unless otherwise specified with equipment	See System No. 29, Section 09900, PAINTING
Anchor Bolts Cast Into Concrete for Metal Fabrications and Structural Components:		
Dry or Protected Areas	Zinc-coated steel bolts	
Exterior, Wet, and Washdown Areas	Stainless steel bolts with fusion bond coating	See System No. 29, Section 09900, PAINTING
Anchors for Metal Components to Concrete; e.g., Electrical Panels and Equipment:		
Dry Areas	Galvanized or stainless steel wedge or expansion anchors	
Wet and Damp Areas	Epoxy or adhesive stainless steel anchors	
Submerged or Buried in Earth	Epoxy or adhesive stainless steel anchors	
Connections for Structural Steel Components:		
Exterior and Interior	High-strength steel bolts	See Section 05120, STRUCTURAL STEEL

Service Use and Location	Product	Remarks
Connections for Steel Fabrications and Wood Components:		
Exterior and Interior	Zinc-coated steel bolts	
Connections of Aluminum Components:		
Exterior and Interior	Stainless steel bolts	
All Others:		
Exterior and Interior	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on all stainless steel threads.

C. Do not use epoxy anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

END OF SECTION

SECTION 05530
METAL GRATING

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Grating: Show dimensions, weight, and size, and location of connections to adjacent grating, supports, and other Work.
2. Grating Anchorage: Show structural calculations and details of anchorage to supports to prevent displacement from traffic impact.
3. Grating Supports: Show dimensions, weight, size, location, and anchorage to supporting structure.
4. Catalog information and catalog cuts.
5. Manufacturer's specifications, to include coatings.

B. Quality Control Submittals:

1. Special handling and storage requirements.
2. Installation instructions.
3. Factory test reports.
4. Manufacturer's Certification of Compliance for specified products.
5. Written Test Report that swaged crossbars, if used on grating, meet the requirements of the specified test and additional requirements of these Specifications.

1.2 PREPARATION FOR SHIPMENT

A. Insofar as is practical, factory assemble items provided.

B. Package and clearly tag parts and assemblies that are of necessity shipped unassembled and protect the materials from damage, and facilitate identification and final assembly in the field.

PART 2 PRODUCTS

2.1 FOOT TRAFFIC GRATING

A. Design:

1. Uniform Service Load: 100 psf minimum, unless otherwise shown.
2. Maximum Deflection: 1/4 inch, unless otherwise shown.
3. Space bearing bars at 1-3/16-inch center-to-center.
4. Banding: 3/16-inch minimum.

B. Material:

1. Aluminum Bar Type Grating:

a. Press-locked rectangular design, as manufactured by IKG/Borden, Clark, NJ; IKG/Borden Type B or Type F.
b. Swage locked aluminum grating, rectangular bar type, as manufactured by:
   1) IKG/Borden, Clark, NJ; IKG/Borden Type BS or Type FS.
   2) Seidelhuber Metal Products Inc., San Carlos CA; Type A-2.
   3) Ohio Gratings, Inc., Canton, OH; Aluminum Flush Top, Type 19SGF2.
   4) Klemp Corp., Chicago, IL; Type KRP.
c. Swage locked aluminum I-bar grating, as manufactured by:
   1) IKG/Borden, Clark, NJ; Type IF.
   2) Seidelhuber Metal Products, Inc., San Carlos, CA; Type 19SI2.
   3) Ohio Gratings, Inc., Canton, OH; Type 19 SGI 2.
   4) Klemp Corp., Chicago, IL; Type KIP.

2.2 ACCESSORIES

A. Anchor Bolts and Nuts:

1. Carbon Steel: ASTM A307-91 or A36-90.
2. Stainless Steel: ASTM A193-90a and ASTM A194-91, Type 316.
3. Galvanized Steel Bolts and Nuts: ASTM A153-82, zinc coating for ASTM A307-91 or A36-90.

B. Flat Washers (Unhardened): ASTM F844-90; use ASTM A153-82 for zinc coating.

C. Removable Fastener Clips and Bolts:

1. Removable from above grating walkway surface.
2. Hat Bracket: Type 304 stainless steel.
3. Bolt: Type 316 stainless steel.
4. Cast iron, galvanized body.
5. Manufacturer and Product: Struct-Fast, Wellesley Hills, MA; Gratefast.

D. Partially Removable Anchor:

1. Bolt: Threaded stud, Type 316 stainless steel.
   a. Manufacturer: Nelson Stud Welding Co., Loraine, OH.
2. Hat Bracket: Type 304 stainless steel.
   a. Manufacturer: STRUCT-FAST, Wellesley Hills, MA.

2.3 FABRICATION

A. General:

1. Exposed Surfaces: Smooth finish and sharp, well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in a neat, substantial manner.
3. Conceal fastenings where practical.

4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Weld Connections: Not permitted on grating except at banding bars.

B. Design:

1. Field measure areas to receive grating, verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.
2. Section Length: Sufficient to prevent its falling down through clear opening when oriented in the span direction when one end is touching either the concrete or the vertical leg of grating support.
3. Minimum Bearing: ANSI/NAAMM MBG 531-88.
4. Metal Crossbar Spacing: 4-inch maximum, unless otherwise shown or specified.
5. Crossbars: Flush with top of main bar and extend downward a minimum of 50 percent of the main bar depth.
   a. Swaged Crossbars:
      1) Within 1/4 inch of top of grating with 1/2-inch minimum vertical dimension after swaging, and minimum before swaging dimension of 5/16-inch square.
      2) Crossbar Dimension After Swaging: Minimum 1/8-inch wider than the opening at minimum of two corners at each side of each square opening in main bar.
      3) Crossbars may be a special extruded shape so that after swaging the top will be flat, 3/16 inches wide and will be flush with the top surface of the bearing bars for a minimum of 5/8 inches at center between bearing bars.
      4) Flush crossbar meeting all of the above except that after swaging shall overlap one corner by a minimum of 1/8 inch. A sample of one bearing bar and one crossbar shall be tested by holding the bearing bar and pulling on the crossbar. The crossbar to bearing bar shall sustain a minimum of 300 pounds without pullout of the bearing bar.
      5) Tightly fit main bars and crossbars allowing no differential movement.
6. Do not use weld type crossbars.
7. Banding: Same material as grating; ANSI/NAAMM MBG 531-88 and ANSI/NAAMM MBG 532-88.
8. Furnish stainless steel Type 316 threaded anchor studs, as fasteners for grating attachment to metal supports either not embedded or partially embedded in concrete, as manufactured by Nelson Studs Welding Co., Loraine, OH.

C. Supports:

1. Seat angles and beams where shown:
   a. Same material as rectangular bar grating.
   b. Extruded aluminum frame with slot for recessed grating clips, as manufactured by Thompson Fabricating Co., for aluminum I-Bar type grating.
2. Coordinate dimensions and fabrication with grating to be supported.
3. Coordinate dimensions with increased depth due to serrations.

4. Welded Frames With Anchors: Continuously welded.

D. Slip-Resistant Surface:

1. Rectangular Aluminum Bar Grating: As manufactured by:
   a. IKG/Borden, Clark, NJ; EZ Weldslip-Resistant Coating.
   b. Seidelhuber Metal Products, Inc., Hayward, CA; Safety Grit Non-Slip System.
   c. Ohio Gratings, Inc., Canton, OH with "Slip-Not" Safety Surface manufactured by W.S. Molnar Co., Detroit, MI.
2. I-Bar grating aluminum shall incorporate a striated antiskid walking surface produced during the extrusion process, as manufactured by:
   a. IKG/Borden, Clark, NJ.
   b. Seidelhuber Metal Products, Inc., Hayward, CA.
   c. Klemp Corp., Chicago, IL.

E. Aluminum:

1. ASTM B221-91 extruded shapes.
2. Fabricate as shown and in accordance with manufacturer's recommendations.
3. Grind smooth sheared edges exposed in the finished work.
4. Swage crossbars, if used, with equipment strong enough to deform crossbars.
5. Eliminate any loose crossbar intersections on swaged grating.

F. Foot Traffic Grating: Any single grating section shall be not less than 1 foot 6 inches or greater than 3 feet 0 inch in width or weigh more than 150 pounds.

PART 3 EXECUTION

3.1 PREPARATION

A. Electrolytic Protection:

1. Aluminum in contact with dissimilar metals, other than stainless steel, and embedded or in contact with masonry, grout, and concrete, protect surfaces as specified in Section 09900, PAINTING, System No. 27.
2. Allow paint to dry before installation of the material.

3.2 INSTALLATION

A. Install supports such that grating sections have a solid bearing on both ends, and that rock and wobble grating movement does not occur under designed traffic loading.

B. Install plumb or level as applicable.

C. Install welded frames with anchors to straight plane without offsets.

D. Anchor grating securely to supports using minimum of four fastener clips and bolts per grating section.

E. Use stainless steel anchors and accessories with aluminum gratings.

F. Completed installation shall be rigid and neat in appearance.

G. Commercially Manufactured Products:

1. Install in accordance with manufacturer's recommendations.
2. Secure grating to support members with fasteners.
3. Welding is not permitted.
4. Fasteners: Field locate and install.
5. Permit each grating section or plank style grating assembly to be easily removed and replaced.

H. Protect painted surfaces during installation.

I. Should coating become marred, prepare and touch up surface in accordance with paint manufacturer's instructions.

END OF SECTION

SECTION 06000
CARPENTRY

PART 1 GENERAL

1.1 QUALITY ASSURANCE

A. Lumber Grades and Wood Species: U.S. Product Standard PS 20-70 and the National Forest Products Association.

1. Wood Members: Requirements above and in "Design Values for Wood Construction", supplement to the 1977 edition of National Design Specification for Wood Construction, published by National Forests Products Association.
2. Identify each piece or bundle of lumber or other product with a recognized mark of the authority grading the product.

B. Plywood Grades: U.S. Product Standard PS 1-83. Identify each plywood panel with appropriate grade trademark of American Plywood Association.

C. Preservative and Pressure Treated Material: American Wood Preservers Association Standards (AWPA) and bear the American Wood Preservers Bureau (AWPB) quality mark designation.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Place materials in dry storage areas immediately upon delivery.

B. Store materials 6 inches minimum aboveground on framework or blocking; cover with protective waterproof covering and provide adequate air circulation or ventilation.

C. Do not subject to extreme changes of temperature or humidity.

D. Protect sheet materials from corner breaks and surface damage while unloading.

PART 2 PRODUCTS

2.1 LUMBER

A. Lumber for Plates, Nailers, and Miscellaneous Blocking: Dimensions given are nominal; surface four sides (S4S); moisture content not over 19 percent, unless specified otherwise; provide as follows:

Usage	Minimum Grade
General framing, studs, plates, blocking, furring, braces, & nailers	Standard & Better or Stud Grade

B. Interior Trim: Douglas fir, C Select Grade, or AWI Custom Grade.

C. Exterior Trim: Western Red Cedar, No. 1 Common or B and Better Select Grade.

2.2 PLYWOOD

A. Roof Sheathing: APA rated sheathing; EXT; 32/16; Structural II.

B. Wall Sheathing: APA rated sheating; EXT; 48/0 for stud spacing of 16 inches or less; Structural II.

2.3 PRESERVATIVE TREATED WOOD

A. Material: Waterborne salt preservatives; AWPA C2 and AWPB LP-2. Furnish sufficient amount for onsite application to sawed or cut surfaces.

2.4 ANCILLARY MATERIALS

A. Vent Screen: Galvanized hardware cloth, 1/4-inch square mesh.

B. Building Paper: Asphalt-saturated felt, ASTM D226-89, Type II (No. 30) plain, unperforated.

C. Hardware: UBC Standard No. 25-17.

1. Nails: Steel common nails for framing, sizes as shown; hot-dipped zinc-coated nails where exposed; deformed shank nails for fastening underlayment.
2. Bolts and Screws: ASTM A307-91, galvanized where exposed.
3. Framing Anchors: Simpson, Teco, or Bowman galvanized 18-gauge steel, complete with nails.
4. Provide fasteners and miscellaneous hardware required for assembling and anchoring finish woodwork.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces to receive carpentry items are prepared.

3.2 PREPARATION

A. Do not install finish interior woodwork until the building has been dried for at least 10 days.

3.3 ROUGH CARPENTRY ERECTION

A. Preservative Treated Wood:

1. Use for framing, blocking, furring, nailing strips built into exterior masonry walls, wood in contact with concrete and in conjunction with gravel stops, and built-up roofing.
2. Apply two brush coats of same preservative used in original treatment to all sawed or cut surfaces of treated lumber.

B. Plates:

1. Set plates level and flush with inside face of wall or as shown.
2. Anchor as shown.

END OF SECTION

SECTION 06190
PREFABRICATED WOOD TRUSSES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Design of hip truss system for the Upstream Dam Control Building including all connections, following configurations shown and loads listed on Drawings.

1.2 DEFINITIONS

A. SPIB: Southern Pine Inspection Bureau.

B. TPI: Truss Plate Institute.

1.3 SUBMITTALS

A. Shop Drawings:

1. Shop Drawings showing species and stress grades of lumber, all dimensions, camber, spacing of trusses in building, connector types, detail of connectors, and bracing requirements. Include an elevation view drawings of trusses of sufficient scale to show all details of construction. Roof framing plan.
2. Product data for lumber, metal connector plates, hardware, fabrication process, and fasteners.
3. Design Data: Calculations for stresses in all members and connections. Calculations stamped and signed by an Arizona registered civil engineer.
4. ICBO No. of listed truss design.

B. Quality Control Submittals:

1. Certificates: Manufacturer's Certificate of Compliance.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Connector Plate Manufacturer: Member of TPI and complies with TPI quality control procedures for manufacture of connector plates published in TPI QST-88.
2. Engineer: Registered professional engineer legally authorized to practice in jurisdiction where Project is located and experienced in providing engineering services that has resulted in the installation of wood trusses similar to those of this Project.
3. Fabricator: Firm that is experienced in prefabricating wood trusses similar to those of this Project and participates in a recognized quality assurance program that involves inspection by SPIB and TPI.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle and store trusses with care and comply with manufacturer's instructions and TPI recommendations to avoid damage from bending, overturning, or other causes which trusses are not designed to resist or endure.

PART 2 PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Prefabricated wood trusses include planar structural units consisting of metal-plate-connected members that are fabricated from dimensional lumber and have been cut and assembled prior to delivery to the Project site.

B. Comply with requirements and recommendations of the following TPI publications:

1. TPI (1985; Errata; Supplement).
2. QST-88.
3. BWT-76.

C. Design trusses to suit conditions shown on Drawings and to meet local building codes.

2.2 LUMBER

A. Factory mark each piece of lumber with type, grade, mill, and grading agency.

B. Use lumber complying with PS 20 (1970; Amendment 1986) and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.

C. Dressed lumber, S4S, manufactured to actual sizes required by PS 20 (1970; Amendment 1986) to comply with the following:

1. Moisture Content: Seasoned, with 19 percent maximum moisture content at time of dressing and shipment for sizes 2 inches or less in nominal thickness.
2. Species and grade that complies with the following for species group as defined in NFOPA 01 (1986; Supplement June 1988; Rev May 1990), for extreme fiber stress in bending "Fb" for single and repetitive members, and for modulus of elasticity "E":
   a. Chord Members: "Fb" of 1,500 psi for single member use and of 1,750 psi for repetitive member use, and "E" of 1,600,000 psi.
   b. Web Members: "Fb" of 1,300 psi for single member use and 1,500 psi for repetitive member use, and "E" of 1,600,000 psi.

2.3 CONNECTOR PLATES

A. Hot-Dip Galvanized Steel Sheet: Structural (physical) quality steel sheet complying with ASTM A446-91, Grade A; zinc coated by hot-dip process to comply with ASTM A525-90a, Designation G60; minimum coated metal thickness not less than 0.036-inch.

2.4 FASTENERS

A. General: Furnish fasteners with a hot-dip zinc coating in accordance with ASTM A153-82 (REV 1987) or AISI SS502-76.

B. Nails, Wire, Brads, and Staples: FS FF-N-105 (Rev B; Int Am 4).

C. Power Driven Fasteners: National Evaluation Report NER-272.

D. Wood Screws: ANSI B18.6.1-81.

E. Lag Bolts: ANSI B18.2.1-81.

F. Bolts: Steel bolts complying with ASTM A307-90, Grade A; with ASTM A563-90 hex nuts and flat washers.

2.5 METAL FRAMING ANCHORS

A. Galvanized Steel Sheet: Steel sheet zinc-coated by hot-dip process on continuous lines prior to fabrication to comply with ASTM A525-91a for Coating Designation G60 and with ASTM A446-90, Grade A (structural quality).

2.6 FABRICATION

A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints with wood-to-wood bearing in assembled units.

B. Fabricate metal connector plates to size, configuration, and thickness required to withstand design loadings.

C. Fabricate and assemble truss members to design configuration shown on Drawings with joints closely fitted to comply with tolerances specified in TPI QST-88.

D. Connect truss members by means of metal connector plates and securely fasten to each side of wood members.

PART 3 EXECUTION

3.1 INSTALLATION

A. Erect and brace trusses to comply with TPI BWT-76.

B. Where trusses do not fit, return them to fabricator and replace with trusses of correct size; do not alter configuration of trusses in the field.

C. Follow manufacturer's instructions for handling and erection.

D. Erect trusses with plane of truss webs vertical, plumb, and parallel to each other.

E. Exercise care to keep out-of-plane bending of trusses to minimum. Install temporary horizontal and cross-bracing to hold trusses until permanent bracing is installed.

F. Anchor trusses securely at all bearing points.

G. Install permanent bracing and related components prior to application of loads to trusses. Tighten loose connectors. Restrict construction loads to prevent overstressing of truss members. Do not cut or remove truss members.

H. Fasten securely to wall framing and other structural components. Brace, block, and bridge as soon as possible after placement.

END OF SECTION

SECTION 07160
BITUMINOUS DAMPPROOFING

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings: Manufacturer's product data for dampproofing materials.

B. Quality Control Submittals:

1. Manufacturer's application instructions for dampproofing materials.
2. Manufacturer's Certificate of Compliance.
3. Statement of Qualification: Bituminous dampproofing installer.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Engage experienced installer who has completed bituminous dampproofing work similar in material, design, and extent for Project.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store materials in area where temperatures are not less than 50 degrees F or over 85 degrees F.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Weather: Proceed with dampproofing Work only when existing and forecast weather conditions will permit Work. Do not apply dampproofing in rainy conditions or within 3 days after surfaces become wet from rainfall or other moisture.

B. Temperature:

1. Do not apply materials when ambient temperature is less than 50 degrees F.
2. Do not apply materials when low temperature of 40 degrees F or less is predicted within a period of 24 hours after application.

PART 2 PRODUCTS

2.1 BITUMINOUS DAMPPROOFING, GENERAL

A. Odor Elimination: Provide type of bituminous dampproofing material warranted by manufacturer to be substantially odor-free after drying for 24 hours under normal conditions.

2.2 COLD-APPLIED ASPHALT EMULSION DAMPPROOFING

A. Asphalt Emulsion: Asphalt and water emulsion coating, formulated to penetrate substrate and build to moisture-resistant coating.

1. Heavy fibrated type mastic asbestos-free emulsion; ASTM D1227-87, Type IV, except containing nonasbestos, inorganic fibrous reinforcement materials.

B. Manufacturers:

1. Celotex Corp.
2. ChemRex, Inc./Sonneborn Building Products Div.
3. J & P Petroleum Products, Inc.
4. Koch Materials Co.
5. Tremco, Inc.

2.3 DRAIN FABRIC

A. A system of a three-dimensional plastic grid to allow drainage, bonded to a geo-membrane fabric; Miradrain 2000 or equal.

2.4 DRAIN PIPE

A. 3-inch diameter, flexible, perforated, poly drain pipe.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

A. Clean surfaces to remove dust, dirt, oil, wax, efflorescence, and other foreign materials, in accordance with dampproofing manufacturer's instructions.

B. Allow 3 days' drying time following washing down of substrate surfaces.

C. Fill cracks, voids, and honeycombs with mortar to provide sound surface for dampproofing.

3.2 APPLICATION

A. Apply materials at rate and as recommended by the manufacturer and in two coats.

B. Start application at top of wall and work down surface, keeping a wet edge at all times, forming a continuous, unbroken film, free from pinholes and other surface breaks.

C. Apply drain fabric and drain pipe to earth side of building walls on uphill side of the downstream control building as shown on the Drawings.

3.3 FIELD QUALITY CONTROL

A. Inspection: Examine surfaces to receive dampproofing to assure conditions are satisfactory for application of materials.

B. After dampproofing has dried, spray surfaces with water.

C. Recoat, as recommended by manufacturer, surfaces showing water absorption. To prevent blistering, protect surfaces from heat and direct sunlight until dried.

3.4 ADJUST AND CLEAN

A. Clean spillage and overspray from adjacent surfaces as recommended by manufacturer.

3.5 APPLICATION SCHEDULE

A. Dampproof areas shown and as follows: Apply dampproofing to exterior surfaces of concrete masonry structures below finish ground level that enclose spaces that may be occupied.

B. On belowgrade walls apply dampproofing from top of footings to 6 inches below finished grade.

C. Apply drain fabric against dampproofing, set drain pipe, and overlap with fabric.

END OF SECTION

SECTION 07175
WATER-REPELLENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work necessary to furnish and apply, complete, a clear, VOC compliant polysilane-based, water-repellent system, where indicated on the Drawings.

1.2 SUBMITTALS

A. Product Data:

1. Manufacturer's Literature: Manufacturer's literature shall be submitted for review before work is started. Literature shall show material specifications, manufacturer's estimated application rate for each surface to which the stain is to be applied, current application instructions, directions of the manufacturer, and safety precautions.
2. Manufacturer's application recommendations for technique, application rate, and methods specific to this project.

B. Quality Control Submittals: Letter or other documentation from the materials manufacturer stating that the installer has been trained and approved to apply the water repellent.

C. Contract Closeout Submittals: Manufacturer's warranty identifying project name, location, date, and type of material applied.

1.3 QUALITY ASSURANCE

A. Qualifications of Applicator: Water repellent shall be applied by a properly qualified applicator with basic knowledge of the material and application procedures.

B. Requirements of Regulatory Agencies: Solvents used in the formulation of the water repellent shall conform to all local, state, and federal air quality control standards.

C. Manufacturer's Service:

1. Prior to commencement of application to wall surface, manufacturer shall inspect all surfaces to be treated. All deficiencies or flaws in the overall construction of the substrate which would ultimately affect the performance or application shall be noted in writing and a copy delivered to the following parties:
   a. Subcontractor.
   b. General CONTRACTOR.
   c. RESIDENT ENGINEER.
   d. OWNER's Representative.
2. Manufacturer's representative shall be present at commencement of application to assure utilization of proper equipment, verify material

quantities, supervise material application techniques, and supervise the onset application.

3. Manufacturer's representative will inspect all treated surfaces after application to assure complete product utilization, aesthetic effect, and material performance.

D. CONTRACTOR's Requirements:

1. CONTRACTOR shall comply with recommendations and instructions set forth by manufacturer as part of manufacturer's service in addition to complying with the terms of the manufacturer's warranty and the following:
   a. CONTRACTOR shall certify that quantity is sufficient to meet manufacturer's minimum surface area coverage requirements for warranty application.
   b. CONTRACTOR shall not proceed with application until such time that all deficiencies previously noted in the manufacturer's preapplication inspection have been properly corrected.
   c. CONTRACTOR shall notify manufacturer no less than 72 hours prior to commencement of work. Manufacturer's representative shall be present at job commencement to verify material quantities, inspect application equipment, and supervise application startup.
   d. CONTRACTOR shall not proceed with material application until such time that the Manufacturer has issued a Certificate of Preapplication Inspection and written verification of specified material quantity purchase.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original sealed containers, clearly marked with the manufacturer's name, brand name, type of material, batch number, percent solids by weight and volume, and date of manufacture.

B. Store materials in an area where temperature will not be less than 50 degrees F (10 degrees C) or more than 85 degrees F (29 degrees C).

1.5 ENVIRONMENTAL CONDITIONS

A. Temperature and relative humidity conditions during time of application shall be per manufacturer's application instructions and precautions. Do not apply material under rainy conditions or within 4 to 7 days after surfaces become wet from rainfall or other moisture. Do not apply when weather is foggy or overcast.

B. Take precautions to ensure that workmen and work areas are adequately protected from fire and health hazards resulting from handling, mixing, and application of material.

C. Furnish all scaffolding and all necessary equipment to complete the work.

D. Provide drop cloths and other forms of protection necessary to protect all adjoining work and surfaces, and render them completely free of overspray

and splashes. Any surfaces that have been damaged or surfaces that have been splattered shall be cleaned, restored, or replaced to the satisfaction of the RESIDENT ENGINEER.

E. Application of the water repellent shall be completed prior to applying sealant between exterior joints.

F. Surfaces to be treated must be cleaned and free from dirt, grease, and foreign matter. Concrete masonry unit and stucco surfaces shall be cured a minimum of 28 days.

1.6 WARRANTY

A. Manufacturer's Warranty: 5 years.

B. CONTRACTOR's Warranty: CONTRACTOR shall, upon completion of work contained herein, issue a written warranty to the OWNER covering workmanship and material. Said warranty shall become effective upon completion and acceptance of work under this section by manufacturer's representative and shall cover workmanship for 5 years and include material manufacturer's warranty against flaking or peeling for 5 years.

PART 2 PRODUCTS

2.1 MATERIALS

A. Clear, polysilane-based formulation of active chemical ingredients that bond to the masonry substrate to create a deep-penetrating clear, chemical-reactive waterproofing containing no silicone oils, paraffin wax, or urethanes.

2.2 MANUFACTURERS AND PRODUCTS

A. Rainguard, Inglewood, CA; Rainguard with Micro-Lok.

B. Or Equal Submitted With:

1. Product Data: Manufacturer's specifications, installation instructions, general recommendations, and data substantiating that materials proposed are recommended by manufacturer for applications indicated.
2. Product Quality: Data substantiating that product performance, product warranty, and onsite supervision services are equal to that of specified manufacturer.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACES

A. Surfaces to receive water repellent shall be structurally sound, clean, dry, fully cured, and free from dust, curing agents or form releasing agents, efflorescence, scale, or other foreign materials. Methods and materials

used for cleaning of substrate shall be as recommended by the manufacturer of the water repellent.

3.2 APPLICATION

A. Material shall be applied using methods and equipment recommended by the water repellent manufacturer. A copy of the manufacturer's printed application instructions and precautions shall be kept at the jobsite.

B. Material shall be applied at a rate recommended by the manufacturer to achieve evenness and complete water repellency.

C. Application technique shall be in accordance with manufacturer's specification. Start application at top of wall and work down surface. Unless otherwise recommended, each application shall be first in a uniform horizontal direction, followed by a uniform overlapping vertical direction. Feather-edge at each pass and maintain a continuous wet edge. Work shall be scheduled so that the stopping point each day falls at inside or outside corners only.

3.3 CLEANUP

A. Clean up any drips, runs, and overspray from adjacent surfaces, as recommended by the water repellent manufacturer.

3.4 FIELD QUALITY CONTROL

A. All drums containing water repellent shall not be removed from the jobsite until final completion and until so authorized in writing by the RESIDENT ENGINEER.

END OF SECTION

SECTION 07210
BUILDING INSULATION

PART 1 GENERAL (NOT USED)

PART 2 PRODUCTS

2.1 BATT INSULATION AND FASTENERS

A. Fiberglass or Mineral Wool Batts: ASTM C665-88, Type II, Class A, with 1 perm rating, nonreflective kraft paper vapor-resistant membrane laminated to one side with R-values as indicated on the Drawings.

1. Widths: As required by framing spacing.
2. Manufacturers:
   a. Manville.
   b. Owens-Corning Fiberglas Corp.
   c. U.S. Gypsum.
   d. Certainteed.

B. Fasteners: Galvanized flattened steel staples with 7/16-inch minimum crown and 1/2-inch minimum shank.

2.2 SILL SEALER

A. Fiberglass or Mineral-Fiber Insulation Rolls:

1. Size: 1-inch thick by 6 inches wide.
2. ASTM C665-88, Type I.

PART 3 EXECUTION

3.1 INSTALLATION

A. Batt Insulation: Locate and install as indicated and in accordance with manufacturer's instructions, except as specified below:

1. Install faced batt insulation with vapor retarder facing warm side.
2. Fit tightly to ensure continuous seal.
3. Where electrical outlets, ducts, pipes, vents, or other utility items occur, place insulation on cold weather side of obstruction.
4. Protect installed insulation from tears and other damage until covered with finish material.
5. Remove and replace damaged material.

B. Sill Sealer: Install under wood plates resting on concrete or masonry walls.

END OF SECTION

SECTION 07531
HYPALON ELASTIC SHEET ROOFING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work necessary to furnish and install, complete, mechanically attached Hypalon elastic sheet roofing and rigid roof insulation for a Class B roof covering system.

1.2 SUBMITTALS

A. Product Data:

1. List of materials proposed for use including roofing materials, accessories, insulation, and fasteners.
2. Manufacturer's specifications selected for use, including a description of the complete system from the deck up.
3. Documentation that anchoring system meets uplift requirements.

B. Shop Drawings:

1. Layout of tapered insulation.
2. Layout and details of mechanical fastening system.

C. Quality Control Submittals:

1. A letter or other documentation from roofing materials manufacturer stating that installer has been trained and approved to apply the roof.
2. Manufacturer's certification of compliance that all roofing system materials meet the ASTM Specifications referenced.
3. Sample copy of guarantee to be provided. Upon completion of Work and following manufacturer's approval of installation, submit an executed guarantee.
4. Documentation that materials including membrane and insulation are U.L. listed for the classification specified. Submit classification system number from U.L. Directory of Roofing Materials and Systems.

D. Contract Closeout Submittals: Manufacturer's maintenance manual, identified with Project name, location, and date; type of roofing applied; and surface to which system was applied, including sketches where applicable; include recommendations for periodic inspections, care, and maintenance; identify common causes of damage with instructions for temporary patching until permanent repair can be made.

1.3 QUALITY ASSURANCE

A. Installer:

1. Trained and approved by the roof membrane manufacturer.
2. Have a minimum of 3 years' experience in the installation of roofing and flashing specified herein.

B. Preroofing Conference: Prior to installation of roofing and associated Work, meet at Project site with installer, roofing manufacturer, installers of related work, and other entities concerned with roofing performance including (where applicable) 's insurer, test agencies, governing authorities, and RESIDENT ENGINEER. Record discussions and agreements and furnish copy to each participant.

C. Inspection: Upon completion of installation, an inspection shall be made by a representative of membrane manufacturer to ascertain that the roofing system has been installed according to published specifications and details. Guarantee shall be issued upon approval of installation.

D. Notify the manufacturer's representative when the roofing installation is ready for final inspection.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened containers and rolls with labels intact and legible.

B. Handle roll goods so as to prevent damage to edge or ends. Store roll goods on end.

C. Store rigid roof insulation materials on clean, raised platforms.

D. Protect materials against direct sunlight, wetting, moisture absorption, mud, dust, sand, oil, grease, dirt, and construction traffic.

1.5 GUARANTEE

A. Furnish a written guarantee for 15 years after date of substantial completion of the contract which covers all costs for repairs required to maintain roofing system in watertight condition.

B. Guarantee shall cover natural deterioration of the roofing system due to ordinary wear and tear by the elements and defects due to faulty materials or workmanship.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide materials used in roofing system as furnished or approved by one manufacturer.

B. Manufacturers and Products:

1. J. P. Stevens and Co., Inc.; Stevens Elastomerics/Roofing Systems, Northampton, MA, Hi-Tuff.
2. Burke Industries, San Jose, CA; Burkeline Roofing Systems.
3. Gates Engineering Co., Inc.; Wilmington, DE, System III Hypalon.

2.2 MEMBRANE MATERIALS

A. 0.045-inch (1.1 mm) thick, scrim-reinforced uncured Hypalon (CSPE), with the following properties:

Property (Metric-SI Units)	Test Method	Specification
Weight, Minimum (Mass)	ASTM D751	0.29 lbs/ft^2 (1.41 Kg/M^2)
Thickness Tolerance	ASTM D751	$\pm$10 percent
Breaking Strength, Minimum	ASTM D751, Grab Method	225 pounds
Tear Strength, Minimum	ASTM D751, Tongue Tear	90 pounds
Low Temperature Bend, 1/8-inch Mandrel	ASTM D2136	-40 degrees F (-40 deg C) Pass
Shore A Hardness	ASTM D2240	80 $\pm$5
Heat Aging	ASTM D573 7 days at 200 deg F (93.3 deg C) retention of tensile	Maintains 100% of original breaking strength
Volatility, Maximum Volatile Loss	ASTM D1203, Method A	0.5 percent
Hydrostatic Resist-ance, Minimum	ASTM D751, Method A	300 psi
Ozone Resistance	ASTM D1149, 3 ppm at 30% strain at 104 deg F (40 deg C): 72 hrs and 2,500 hrs	No effect
Emmaqua Concentrated Natural Sunlight, 3 Million Langleys	ASTM E838	No visible surface cracking or stiffening
Dimensional Stability	ASTM D1204 24 hrs at 129.2 deg F (54 degrees C)	0.1 percent
Puncture Resistance, Minimum	FTM 191 B, Method 2031	200 pounds
Dynamic Impact/ Puncturing (Watertight After Impact of [in ft lbs])	CGSB, 37-GP-52M	1.8 ft lbs (2.45 J)

Property (Metric-SI Units)	Test Method	Specification
Water Absorption Change in Mass (%)	ASTM D570	Not to exceed 5% (elastomer only)
Vapor Transmission (gram/square meter in 24 hours)	ASTM E96 Condition BW	0.049 perms

B. Membrane Sheet Size: Maximum 64-1/2-inch width and longest length possible, or largest sheet possible, determined by job conditions.

C. Color: Tan.

2.3 ACCESSORY MATERIALS

A. As supplied by, or approved in writing by, the membrane manufacturer.

B. Flashings:

1. 0.045-inch scrim-reinforced uncured Hypalon.
2. Provide unreinforced 0.055-inch thick, uncured, white Hypalon for field fabricated vent stacks, pipes, and corners.

C. Bonding adhesive, perimeter half sheets, all purpose sealant, primer, seam caulk, overnight seal, mechanical fasteners for membrane, solvent, and termination bar shall be as supplied by the membrane manufacturer.

2.4 RIGID ROOF INSULATION BOARD

A. Use of the following insulations must be compatible with the membrane manufacturer used for the listing classification.

B. Average Aged R-Value For Total Thickness Of Rigid Insulation at Minimum Thickness: Minimum R-18.

C. Polyisocyanurate Foam Board:

1. Meet requirements of Federal Specification HH-I-1972 GEN and HH-I-1972/2 with Factory Mutual Class I approval.
2. Minimum Size: 2 feet by 4 feet.
3. Manufacturers and Products:
   a. Thermal Systems; ThermalGlas with Tri-Lam facer.
   b. Celotex; Hy-Therm.
   c. NRG Barriers; E'NRG'Y 2.
   d. R-Max; Multi-Max FA.
   e. Atlas; ACFoam-II.

PART 3 EXECUTION

3.1 EXAMINATION

A. Notify RESIDENT ENGINEER and manufacturer's representative at least 48 hours before installation of the following: insulation, membrane, or roofing system. Provide safe access to roof.

B. Inspection:

1. Verify work of other trades which penetrates roof deck or requires roof access has been completed.
2. Ensure deck is firm, dry, free of foreign materials, and reasonably smooth. Differential height between adjacent roof deck members of more than 1/8 inch is not acceptable. Repair joints greater than 1/4-inch wide.
3. Report immediately to RESIDENT ENGINEER cracks, breaks, holes, or other unusual irregularities in the surface.

C. Application of roofing constitutes acceptance of roof deck, and its condition cannot be used as an excuse for any subsequent failures should difficulties arise.

3.2 INSTALLATION, GENERAL

A. Comply with membrane manufacturer's instructions, except where more stringent requirements are indicated herein for a U.L. listed Class B mechanically attached roof covering system.

B. Follow membrane manufacturer's standard details for all flashing and termination conditions not shown.

C. Meet Factory Mutual Data Sheet 1-28S requirements for I-90 uplift conditions.

D. Follow applicable recommendations of Factory Mutual Data Sheet 1-29.

E. Apply roofing materials in accordance with all safety and weather conditions required by the roofing manufacturer or as modified by applicable rules and regulations of local, state, and federal authorities having jurisdictions.

F. Environmental Considerations:

1. Contact adhesives and primer are extremely flammable. Avoid open flame, sparks, or smoking while handling.
2. Contact adhesives and primer contain petroleum distillates. Avoid breathing vapors or using within an enclosed, nonventilated area.
3. All surfaces to be adhered must be dry before and throughout entire application.

4. Do not apply membrane during inclement weather. When air temperature is below 40 degrees F (44 degrees C), consult membrane manufacturer for special techniques.
5. Meet Factory Mutual requirements for I-90 uplift conditions.

G. Insulation Installation:

1. Keep insulation dry before and during application.
2. Apply rigid insulation where and to R-value specified.
3. Lay insulation with longest dimension perpendicular to direction of membrane seams with joints staggered over roof area to be covered.
4. Butt boards as closely as possible with no gaps over 1/4 inch.
5. Mechanically fasten insulation to deck to roofing manufacturer's instructions.
6. Fasteners shall not penetrate more than 1-inch through deck.
7. Do not install more insulation each day than can be covered with membrane before end of day or start of inclement weather.

3.3 MEMBRANE INSTALLATION

A. Attach membrane with screws and plates to metal decks.

B. Perimeter Half Sheets:

1. Install two at exterior roof perimeters not bordered by a parapet wall or an adjoining building that is minimum 24 inches higher than roof level.
2. Lay out in pattern as per manufacturer's instructions.
3. Install plates and fasteners along the leading edge of the membrane through insulation and into roof deck.

C. Field Sheets:

1. Unroll membrane on an area to be covered, with edge of roll aligned on seaming line provided.
2. Install plates and screws along the leading edge of membrane through insulation, and into roof deck.
3. Adjoining rolls of membrane shall overlap fastened edge of installed membrane by 4.5 inches.

D. Lap Splice:

1. Overlap membrane 4.5 inches as marked on top side of membrane, and hot-air weld per manufacturer's instructions.
2. Hot-air welding of exposed and cured membrane:
   a. Ensure surfaces to be primed are clean and dirt-free. Remove dirt by washing with detergent. Rinse thoroughly, allow to dry, and then wipe cured surface with approved solvent.
   b. Brush or roller-apply approved primer. Allow the primer to surface dry (5 minutes or less). Do not allow primer to dry more than 30 minutes. If this occurs, reapply primer.

c. Position membrane to be welded to the cured membrane in-place.
d. Weld the two sheets of membrane together as if they were two uncured sheets.

3. Upon completion of hot-air-welded laps, allow membrane to cool.
4. Inspect entire lap and make repairs if necessary.
5. Caulk cut edges by applying seam caulk.
6. The temperature of the sheet and primer must be above 40 degrees F (4.4 degrees C) and rising.

3.4 PERIMETER FASTENING

A. Perimeter or Curb Flashing:

1. Mechanically fasten membrane 12 inches OC through plate, membrane, and insulation into deck.
2. Fasten at parapet wall, curbs, skylights, and other roof penetrations exceeding 24 inches in any dimension.

3.5 FLASHING

A. Install perimeter, curb, vents, drains, and other detail flashing as shown in manufacturer's standard detail drawings and as follows:

1. Apply approved bonding adhesive to both underside of flashing and surface to which it is to be bonded, at a rate of approximately one gallon per 60 square feet of surface coverage.
2. Do not apply bonding adhesive to that portion of flashing that overlaps onto itself. Use hot-air welding throughout the system where membrane overlaps itself.
3. Allow bonding adhesive to dry to finger touch until it does not string or stick to a dry finger. Roll flashing into dry adhesive. Ensure flashing does not bridge where there is any change of direction.
4. Mechanically fasten flashing at the top, under, or through appropriate counter flashing with approved fasteners as shown.
5. Install pipe flashings in accordance with standard details.
6. Install roof drains in accordance with standard details.

3.6 TEMPORARY AND NIGHT SEALS

A. Water Cutoffs:

1. Provide where and when a danger exists that water caused by precipitation may get under the new roofing membrane.
2. Make by securely setting end of membrane in 6-inch wide continuous application of plastic roofing cement and weighing adhered edge to prevent displacement of the cutoff.
3. Remove temporary water cutoffs prior to proceeding with the next work period by cutting off that portion of membrane that has been in contact with plastic roofing cement and disposing of it.
4. Provide water cutoffs at end of each day.

3.7 MISCELLANEOUS WORKMANSHIP CONDITIONS

A. Miscellaneous roofing installation conditions not noted shall meet with membrane manufacturer's recommendations.

3.8 CLEANUP

A. Upon completion of roofing installation, clean up waste material and debris resulting from this operation and dispose of such waste material offsite.

B. Remove spots and smears of asphalt or other material resulting from the work from flashings, copings, mechanical equipment, and other surfaces not intended to be coated with such material. During removal, do not damage the surfaces. Use solvents, if necessary, to clean the materials.

C. Replace any damaged surfaces resulting from the cleaning operation at no additional compensation.

3.9 MANUFACTURERS' SERVICES

A. Furnish a manufacturer's representative for the materials selected to be present at the jobsite to inspect and to certify in writing that the roofing and flashing materials and the Roofing Contractor's work are in accordance with the manufacturer's written instructions and written recommendations.

B. Notify manufacturer's representative at least 48 hours before application of insulation, roofing and flashing, and when roofing installation is ready for final inspection.

C. Inspection:

1. Upon completion of the installation, a membrane manufacturer representative shall make an inspection to ascertain that the roofing system has been installed according to published specifications and details.

2. Deviations or changes from manufacturer's specifications without written approval of the manufacturer, may make Project unacceptable for warranty.

END OF SECTION

SECTION 07610
SHEET METAL ROOFING, FASCIA, AND SOFFIT

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Drawings showing thickness and dimensions of all parts, fastening and anchoring methods, details, and locations of all seams, joints, and other provisions for thermal movement. Include Drawings at not less than 1/4-inch to 1-foot scale and details at not less than 3-inch to 1-foot scale.
2. Two copies of manufacturer's printed installation instructions for preformed systems.

B. Samples:

1. Preformed Systems:
   a. Manufacturer's standard color choices on metal as specified. Printed color samples will be unacceptable. Submit two sets of samples.
   b. Three 12-inch square samples of specified metal. Samples will be reviewed for color and texture only. Compliance with other requirements is the exclusive responsibility of the CONTRACTOR.

C. Quality Control Submittals:

1. Preformed Systems: A letter from the roofing manufacturer stating that the roofer is approved by manufacturer to apply the roof.
2. Field Formed Installation (Copper Roofing and Siding): Statement of qualifications listing years of experience and representative work examples.

D. Contract Closeout Submittals:

1. Preformed Systems: Special guarantee.

1.2 QUALITY ASSURANCE

A. Applicator's Qualifications:

1. Preformed Systems: Approved by the accepted system manufacturer.
2. Field Formed Installation (Copper Roofing and Siding): Installer/fabricator experienced in design, fabrication, and installation of field-formed sheet metal roofing and siding.

B. Preroofing Conference:

1. Conduct preroofing conference with RESIDENT ENGINEER, roofing applicator, roofing system materials manufacturer where applicable, and subcontractors likely to be on the roof, present.
2. Discussion: To resolve questions regarding acceptability of the deck, substrate, roofing system and materials, flashing details, roof insulation, roof-mounted mechanical equipment, and roofing.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Product Delivery: Keep panels dry.

B. Product Storage and Handling:

1. Protect against damage and discoloration.
2. Handle panels with nonmarring slings.
3. Do not bend panels.
4. Store panels aboveground, with one end elevated for drainage.
5. Stack panels to prevent twisting, bending, or abrasion, and to provide ventilation.
6. Protect panels against standing water and condensation between adjacent surfaces.
7. If panels become wet, immediately separate sheets, wipe dry with clean cloth, and separate sheets for air-drying.
8. During storage prevent contact with materials that may cause discoloration or staining.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Apply roofing only in dry weather and when ambient temperature is above 40 degrees F.

1.5 SPECIAL GUARANTEE

A. Product: Provide manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction or, at the option of the OWNER, removal and replacement of roofing panels, flashing, finish, and accessories found *defective* during a period of 20 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of *defective* Work shall be as specified in paragraph 13.12 of the General Conditions.

B. Conditions:

1. Panels: No rupture, structural failure, or perforation.
2. Kynar Finish: No cracking, blistering, flaking, chipping, checking, chalking, peeling, or fading.

PART 2 PRODUCTS

2.1 PREFORMED METAL ROOFING AND FASCIA PANELS

A. Material: Steel, galvanized, ASTM A446-91, Grade A minimum, coating designation G90, or ASTM A792-89 coated steel, 24-gauge minimum metal thickness.

B. Finish:

1. Polyvinylidene Fluoride: Kynar 500, two coats minimum.

C. Standing Seam:

1. Flat panels with upturned edges that are either rolled together or covered with a snap-on cover to form the joints or seams,
2. Interlocking panels not acceptable.
3. Manufacturers and Products:
   a. AEP-SPAN; HS/High Seam.
   b. Fabral Alumax; Slim Seam.
   c. ASC Pacific; Standing Seam.
   d. Berridge; High Seam Tee Panel.
   e. Foremost; No. 801.
   f. MM Systems Corp.; SS225.

2.2 COPPER ROOFING AND SIDING

A. Material: Copper, ASTM B370-88, cold-rolled temper, 16 ounces per square foot.

2.3 METAL SOFFIT PANELS

A. Metal: 0.032-inch ASTM B 209 aluminum.

B. Finish: Kynar 500.

C. Style: 12-inch coverage width with single stiffening V-groove, full vent, concealed fastening, and all trim.

D. Free Area: Minimum of 14.75 percent.

E. Manufacturer: Peterson Aluminum Corp., Tyler, TX, Model PAC-750.

2.4 ACCESSORY MATERIALS

A. Underlayment: ASTM D226-89, Type II or ASTM D2178-89, Type III asphalt roofing felt.

B. Slip Sheet: Rosin-sized building paper, minimum 6 pounds per square (2.5 kilograms per 3 square meters) or Manniglas slip sheet fire-resistant

barrier manufactured by Lydall, Inc., Manning Nonwovens Division, Troy, NY.

C. Fasteners:

1. Stainless steel or alloy appropriate to the particular metal specified for roofing/siding.
2. Screws: Panhead wood or sheet metal type.

D. Solder: ASTM B32-89, Class A, Grade 1, composition 50/50 tin/lead.

E. Soldering Flux: Federal Specification O-F-506, Type 1, Form A or B or type best suited to metal used.

F. Closures: Manufacturer's standard neoprene blocks shaped to fit roof metal profile.

G. Sealant: Type 1 as specified in Section 07900, JOINT SEALANTS.

2.5 FABRICATION

A. Roofing Configuration:

1. Preformed System: Form panels for standing seams spaced no less than 12 inches and no more than 20 inches on center.
2. Field-Formed Installation (Copper Roofing): Concealed fastener 1-inch standing seams at 16 inches (nominal) on center.

B. Siding Configuration: Flat seamed pans with horizontal seams at nominal 19 inches on center.

C. Panel Length: As long as practical, preferably from eave to ridge for roofing and corner-to-corner at siding of vent stack.

D. Fabricate flashings and trim from same metal.

E. Form and fabricate sheets, battens, strips, cleats, valleys, ridges, edge treatments, integral flashings, and other components of specified metal panels to profiles, patterns, and drainage arrangement shown, and as required for permanent leakproof construction.

F. Provide for thermal expansion and contraction of Work.

PART 3 EXECUTION

3.1 SOFFIT INSTALLATION

A. Framing: Verify that framing provides a stable and suitable surface for acceptance of the soffit panels. Report immediately to the RESIDENT ENGINEER any irregularities.

B. Layout: Panels shall be layed out to provide a symmetrical appearance on each side of the building. Corners of soffit shall be mitered. Filler panels to maintain an even module spacing shall be placed at each end of each side (2 per side) immediately after the 45-degree mitered corner panels.

C. Install soffit following manufacturer's instructions for a concealed fastener installation. Provide all trim, flashings, and color matched fasteners.

3.2 ROOFING/FASCIA PANEL AND SIDING INSTALLATION

A. General:

1. Comply with recommendations and instructions of metal roofing panel producer and SMACNA Sheet Metal Manual.
2. Install siding, roofing, and/or fascia system consisting of nonstructural sheet metal panels held to substrate with concealed fasteners, and as required by UBC Chapter 32.
3. Conceal fasteners and expansion joint provisions wherever possible in exposed Work; locate so as to minimize the possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
4. Provide ridges, hips, eaves, rakes, fascia, and other exposed trim and flashings for a weathertight siding, roofing, and/or fascia system.
5. Separate dissimilar metals from each other where electrolysis might occur. Separation is satisfactorily accomplished by coating the metal(s) with a 15-mil bituminous coating. Comply with various metals producers' recommendations for other forms of protection against contamination from corrosive materials or agents.
6. Deck: Firm, dry, free of foreign materials, and smooth. Report immediately to the RESIDENT ENGINEER all cracks, breaks, holes, or other unusual irregularities in the surface.
7. Layout Pattern:
   a. Lay out to place seams equidistant from corners and termination edges. Align with seams on adjacent and opposite sides.
   b. Coordinate Work of this section with flashing, trim, and other construction to provide a permanently leakproof, secure, and noncorroding installation.
8. Metal Roofing, Gutters, Downspouts, and Flashings: Straight, weathertight, exposed surfaces free of dents, scratches, abrasions, stains, and other visible defects.
9. Cutting and Fitting: Neat, square, and true. Saw cut panels, deburr, and use touchup paint immediately as recommended by roofing panel manufacturer. Torch cutting is prohibited.
10. Underlayment:
    a. Apply single-ply lapped shingle fashion, 3 inches at head and 6 inches at sides.
    b. Cover with loose-laid slip sheet similarly lapped and with joints staggered.
    c. Install no more than can be covered in same day.

B. Preformed Metal Roofing/Fascia:

1. Roofing Panels:
   a. Begin at eaves.
   b. Locate holddown clips in joints within 6 inches of panel ends and at 18 inches on center, maximum.
   c. At eaves cut upturned edges and bend panel down to form fascia.
   d. At intersections of roof slope with ridge and hips, turn up edges of roof panels 1 inch.
2. Cross Seams: Not allowed.
3. Seam or Joint Covers:
   a. Snap in-place over clips and upturned edges of roof panels.
   b. At eaves cut sides of covers and fold down over fascia in one continuous piece.
4. Fascia:
   a. Fascia shall be continuous with roofing panel.
   b. Standing seams at roof panel to fascia transition shall be cut, mitered, and covered with manufacturer's standard "knuckle" trim.
   c. Roof panel to fascia transition shall be a crisp, even bend with no signs of oil-canning or waviness.
5. Edges: Hook lower end of roofing into lock strip to form 3/4-inch wide loose-lock seam.
6. Ridge and Hip Covers: Secure in-place using Z-closer clips and fasteners. Seal joints where necessary for weathertightness.

C. Field-Formed Copper Roofing and Siding:

1. Standing Seam Roofing: Install in accordance with SMACNA Sheet Metal Manual, 4th Edition, Plates 120 through 122.
2. Siding: Install in accordance with SMACNA Sheet Metal Manual, 4th Edition, Plate 119 for flat seam.
3. Cleating: Sized and spaced as recommended by referenced guidelines but no less than 12-inch centers.
4. Soldering: All seams and connections to flashing shall be soldered or sealed weathertight.

3.3 CLEANING AND PROTECTION

A. Cleaning:

1. At the end of each day sweep metal clean of foreign materials, especially metal particles and scrap.
2. Peel off all strippable film.
3. Where needed, clean metals in conformance with the metals industry recommendations (American Iron and Steel Institute for stainless steel, Copper and Brass Association for copper, and other associations) or use Basic H organic metal cleaner, Shaklee Products, Hayward, CA.

B. Protection:

1. Protect material from exposure to chlorides, hydrochloric-based and muriatic acids. If contaminated, wash affected areas immediately with 5 percent soda and water solution and rinse with clear water.
2. Avoid walking on roof after completion.

C. Final Cleanup:

1. Remove all debris, metal clips, nails, and other materials that could prevent adequate drainage or produce corrosion products through electrolysis.
2. Repair and touch up damage.

END OF SECTION

SECTION 07620
FLASHING AND SHEET METAL TRIM

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Show joints, types and location of fasteners, and special shapes.
2. Catalog data for stock manufactured items.

B. Samples: Color samples for items to be factory finished.

1.2 DELIVERY, HANDLING, AND STORAGE

A. Package and protect during shipment.

B. Inspect for damage, dampness, and wet storage stains upon delivery to the Work site.

C. Remove and replace damaged or permanently stained materials that cannot be restored to like-new condition.

D. Carefully handle to avoid damage to surfaces, edges, and ends.

E. Do not open packages until ready for use.

F. Store materials in dry, weathertight, ventilated areas until immediately before installation.

1.3 SPECIAL GUARANTEE

A. Product: Furnish manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction or, at the option of the OWNER, removal and replacement of factory-applied fluoropolymer coating, finish, and accessories found *defective* during a period of 20 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of *defective* Work shall be as specified in paragraph 13.12 of the General Conditions.

B. Conditions:

1. Finish: No cracking, blistering, flaking, chipping, checking, chalking, peeling, or fading.
2. All Components: Watertight and weathertight with normal usage.

PART 2 PRODUCTS

2.1 METAL

A. Galvanized Sheet Steel: ASTM A525-91a and ASTM A526-90, G90, commercial quality copper bearing steel, thickness 0.0217 inch (26 U.S. Standard gauge), unless otherwise shown.

B. Copper: ASTM B370-88, hot temper, cold-rolled temper, 16 ounces per square foot.

2.2 REGLETS

A. For Masonry: Galvanized 26-gauge steel, as manufactured by:

1. Superior Concrete Accessories, Franklin Park, IL; Superior Cushion Lock Type B-3.
2. Fry Reglet Corp., Glendale, CA; Fry Springlok Type MA.
3. Cheney Flashing Co.; Type B reglet and Snap Lock Cap Flashing.

B. Surface Mounted: Galvanized 26-gauge steel, as manufactured by:

1. Fry Reglet Corp.; Fry Springlok Type SM.
2. W.P. Hickman Co.; Drive-Lock No. DLR 625.
3. MM Systems Corp.; Snap-Tite, Type RC-1.

2.3 PREFABRICATED METAL SYSTEMS

A. Coping System: Snap-on system, stucco embossed pattern aluminum, 0.050-inch minimum thickness, as manufactured by:

1. W. P. Hickman Co.; Permasnap Coping.
2. MM Systems Corp.; Snap-Lok Coping.

B. Gutter and Downspout System: 0.63-inch, stucco embossed aluminum with factory terminations and all accessories and attachments for a complete system as manufactured by:

1. MM System Corp.; Form-Line.
2. Southern Aluminum Finishing Co.; Industrial Series.

C. Finish: Factory finished with a full strength fluoropolymer coating (Kynar polyvinylidene fluoride resin) in color selected from manufacturer's standards.

2.4 ANCILLARY MATERIALS

A. Solder: ASTM B32-89, alloy composition Sn 50.

B. Soldering Flux: ASTM B32-89, Type RA.

C. Sealer Tape: Polyisobutylene sealer tape.

D. Isolation Paint: ASTM D1187-82, asphalt.

E. Isolation Tape: Butyl or polyisobutylene, internally reinforced, or 20-mil thick minimum polyester.

F. Fasteners:

1. For Galvanized Steelwork: Steel, galvanized per ASTM A153-82 or stainless steel fasteners.
2. Nails: Roofing nailhead, 10-gauge spiral or ring shank, lengths as required to penetrate wood at least 3/4 inch.
3. For Copper Work: Copper or copper alloy.
4. For Coated Metal: Color matched heads.

2.5 THROUGH-WALL FLASHING

A. Copper bonded on both sides with waterproofed creped Kraft paper.

B. Copper Weight: 3 ounces per square foot.

C. Manufacturers:

1. AFCO Products, Inc.; AFCO Cop-A Bond Duplex.
2. York Manufacturing, Inc.; Cop-R-Tex Duplex.

2.6 ROOF CURBS

A. Prefabricated galvanized steel with treated wood nailer and factory installed insulation.

1. Metal Gauge and Reinforcement: To suit imposed loads of equipment to be supported.
2. Manufacturers and Products:
   a. Pate Co.; PC-2.
   b. Thy Curb; Model TC-3.
   c. Custom Curb, Inc.; CRC-3.
3. Fabricate curbs to fit roof slope.

2.7 FABRICATION OF FLASHING

A. Field measure prior to fabrication.

B. Fabricate in accordance with SMACNA Architectural Sheet Metal Manual.

C. Accurately form flashings to shapes shown and detailed, with angles and lines in true alignment.

D. Form arris and angles true to line and surfaces free of waves and buckles.

E. Form bends to 1/16-inch inside radius.

F. Hem exposed edges.

G. Reinforcements and Supports: Provide same material as flashing unless other material is shown. Steel, where shown or required, shall be galvanized or stainless.

H. Rigid Joints and Seams: Make mechanically strong. Solder galvanized metal joints. Do not use solder to transmit stress.

I. Fabricate sheet metal in 10-foot maximum lengths, unless otherwise indicated.

J. At exposed ends of counterflashing furnish weathertight closures.

K. Fabricate corners in one-piece with legs extending 30 inches each way to field joint. Lap, rivet, and solder corner seams watertight.

L. Neutralize soldering flux.

M. Solvent clean sheet metal. Surfaces to be in contact with roofing or otherwise concealed shall be coated with isolation paint.

2.8 FABRICATION OF DOWNSPOUTS AND GUTTERS

A. Fabricate in accordance with SMACNA Architectural Sheet Metal Manual.

B. Form downspouts and gutters in maximum lengths as practicable to sizes and shapes indicated on Drawings.

C. Telescope end joints 1-1/2 inches and lock longitudinal joints of downspouts.

D. Furnish elbows at bottom where downspouts empty onto splash blocks.

PART 3 EXECUTION

3.1 INSTALLATION

A. Flashing:

1. Coordinate flashing Work with roofing Work for weathertight and watertight assembly.
2. Isolate metal from wood and concrete and from dissimilar metal with two coats of specified isolation paint or tape.
3. Joints, Fastenings, Reinforcements, and Supports: Sized and located as required to preclude distortion or displacement due to thermal expansion and contraction.
4. Conceal fastenings wherever possible.

5. Set flashing and sheet metal to straight, true lines with exposed faces aligned in proper plane without bulges or waves.
6. Use only stainless steel fasteners to connect isolated dissimilar metals.
7. Joints: 10-foot maximum spacing and 2-1/2 feet from corners, butted with 3/16-inch space centered over matching 8-inch long backing plate with sealer tape in laps.
8. Provide continuous holddown clips at counterflashing and gravel stops.

B. Downspouts, Gutters, Scuppers, and Conductor Heads: Anchor downspouts to wall with straps of same material as downspouts. Install gutters, scuppers, and conductor heads as indicated on Drawings.

C. Reglets: Install in accordance with manufacturer's latest printed instructions.

D. Prefabricated Systems:

1. Follow system manufacturer's applicable printed instructions.
2. Place color variations in pieces so no extremes are next to each other.

E. Through-Wall Flashing: Lap cross joints at least 2 inches. Stop flashing 1/2 inch from exterior faces of wall.

F. Roof Curb:

1. Install all roof accessories as detailed or in conformance with manufacturer's recommendations and standards.
2. Work shall be weathertight and free of expansion and contraction noise.

3.2 FINISH

A. Exposed Surfaces of Flashing and Sheet Metalwork: Free of dents, scratches, abrasions, or other visible defects, and clean and ready for painting where applicable.

END OF SECTION

SECTION 07900
JOINT SEALANTS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings: Surface preparation and installation instructions. Indicate where each product is proposed to be used.

B. Samples: Material proposed for use showing color range available.

C. Quality Control Submittals:

1. Applicator Qualification: Documentation showing minimum of 5 years' experience installing sealants in projects of similar scope.
2. Certificates of Compliance: Proposed materials meet Specification requirements.

D. Contract Closeout Submittals: Special guarantee.

1.2 ENVIRONMENTAL REQUIREMENTS

A. Ambient Temperature: Between 40 and 80 degrees F (4 and 27 degrees C) when sealant is applied. Consult manufacturer when sealant cannot be applied within these temperature ranges.

1.3 SPECIAL GUARANTEE

A. Product: Furnish manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction or, at the option of the OWNER, removal and replacement of Work specified in this section found *defective* during a period of 5 years after the date of Substantial Completion.

B. Conditions: No adhesive or cohesive failure of sealant.

C. Sealed Joints: Watertight and weathertight with normal usage.

PART 2 PRODUCTS

2.1 SEALANT MATERIALS

A. Sealant Characteristics:

1. Uniform, homogeneous.
2. Free from lumps, skins, and coarse particles when mixed.
3. Nonstaining, nonbleeding.
4. Hardness of 15 minimum and 50 maximum, measured by ASTM C661 method.
5. Immersible may be substituted for nonimmersible.

B. Sealant Color: Unless specifically noted, match the color of the principal wall material adjoining the area of application.

C. Type 2 – Multi-Part Polyurethane, Self-Leveling, Immersible:

1. Polyurethane base, multi-component, chemical curing; ASTM C920-87, Type M, Grade P, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products:
   a. Sonneborn; Sonolastic Paving Joint Sealant.
   b. Pecora Corp.; Urexspan NR-200.
   c. H. S. Peterson Co.; Iso-Flex 880GB.
   d. Mameco International; Vulkem 245.

D. Type 3 – Multi-Part Polyurethane, Nonsag, Immersible:

1. Polyurethane base, multi-component, chemical curing; ASTM C920-87, Type M, Grade NS, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products:
   a. H. S. Peterson Co.; Iso-Flex 881.
   b. Mameco International; Vulkem 922.
   c. Product Research Corp.; PRC 270.

E. Type 5 – One-Part Polyurethane, Immersible:

1. Polyurethane base, single-component, moisture curing; ASTM C920-87, Type S, Grade NS or P, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products for Nonsag:
   a. Sika Chemical Corp.; Sikaflex-1a.
   b. Mameco International; Vulkem 116.
4. Manufacturers and Products for Self-Leveling:
   a. Sonneborn; Sonolastic SL-1.
   b. Mameco International; Vulkem 45.

2.2 BACKUP MATERIAL

A. Nongassing, extruded, closed-cell round polyethylene foam rod, compatible with sealant used, and as recommended by sealant manufacturer.

B. Size: As shown or as recommended by sealant material manufacturer. Provide for joints greater than 3/16-inch wide.

C. Manufacturers and Products:

1. Haveg Industries; Minicel.
2. Dow Corning; Ethafoam SB.
3. Sonneborn; Sonofoam.
4. Hercules, Inc.; HBR.

2.3 ANCILLARY MATERIALS

A. Bond Breaker: Pressure sensitive tape as recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Noncorrosive and nonstaining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Primer: Nonstaining type recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.1 GENERAL

A. Use of more than one material for the same joint is not allowed unless approved by the sealant manufacturer.

B. Install joint sealants in accordance with ASTM C1193-91.

C. Horizontal and Sloping Joints of 1 Percent Maximum Slope: Use self-leveling (Grade P) joint sealant.

D. Steeper Sloped Joints, Vertical Joints, and Overhead Joints: Use nonsag (Grade NS) joint sealant.

E. Use joint sealant as required for the applicable application and as follows:

Joint Size	Sealant Type
Less than 1"	2, 3, or 5,
Less than 2"	2 or 3
Over 2"	Follow manufacturer's recommendation

3.2 PREPARATION

A. Verify that joint dimensions, and physical and environmental conditions, are acceptable to receive sealant.

B. Surfaces to be sealed shall be clean, dry, sound, and free of dust, loose mortar, oil, and other foreign materials.

1. Mask adjacent surfaces where necessary to maintain neat edge.
2. Starting of work will be construed as acceptance of subsurfaces.
3. Apply primer to dry surfaces as recommended by sealant manufacturer.

C. Verify that joint shaping materials and release tapes are compatible with sealant.

D. Examine joint dimensions and size materials to achieve required width/depth ratios.

E. Carefully follow manufacturer's instructions for mixing multi-component products.

3.3 INSTALLATION

A. Use joint filler to achieve required joint depths, to allow sealants to perform intended function.

1. Install backup material as recommended by sealant manufacturer.
2. Where possible, provide full length sections without splices; minimize number of splices.
3. Tape sealant may be used as joint filler if approved by sealant manufacturer.

B. Use bond breaker where recommended by sealant manufacturer.

C. Seal joints around window, door and louver frames, expansion joints, and elsewhere as indicated.

D. Joint Sealant Materials: Follow manufacturer's recommendation and instructions, filling joint completely from back to top, without voids.

E. Joints: Tool slightly concave after sealant is installed.

1. When tooling white or light color sealant, use a water wet tool.
2. Finish joints free of air pockets, foreign embedded matter, ridges, and sags.

F. Tape Sealant: Compress to 50 percent of expanded thickness and install in accordance with manufacturer's instructions.

3.4 CLEANING

A. Clean surfaces next to the sealed joints of smears or other soiling resultant of sealing application.

B. Replace damaged surfaces resulting from joint sealing or cleaning activities.

3.5 JOINT SEALANT SCHEDULE

A. This schedule lists the sealant types acceptable for each joint location. Use as few different sealant types as possible to meet the requirements of Project.

Joint Locations	Sealant Type(s)
Expansion/Contraction & Control Joints At:	
Concrete Walls	3,5
Concrete Floor Slabs	2,5
Masonry Walls	3,5
Material Joints At:	
Wall Penetrations (Exterior)	5
Floor Penetrations	5
Metal Door, Louver Frames	5
Sheet Metal Flashings	5
Other Joints:	
Concrete Form Snap-Tie Holes	5
Threshold Sealant Bed	5
Dam Foundation, Apron Slab, and Abutments	5

END OF SECTION

SECTION 08100
METAL DOORS, FRAMES, AND ACCESS PANELS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings: Applicable information for each type of door and frame, including:

1. Frame conditions and complete anchorage details, supplemented by suitable schedules covering doors and frames.
2. Relate to door numbers used in Contract Drawings.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Properly identify each item with number used in Contract Drawings.

B. Store doors upright, in protected dry area, at least 1 inch off ground or floor and at least 1/4 inch between individual pieces.

PART 2 PRODUCTS

2.1 HOLLOW METAL UNITS

A. Manufacturers:

1. Curries Manufacturing.
2. The Ceco Corp.
3. Fenestra Division, Marmon Group.
4. Mesker Industries, Inc.
5. Monarch Steelcraft, Ltd.
6. Overly Manufacturing Co.
7. Pioneer Industries.
8. Precision Metals, Inc.
9. Republic Steel Corp.
10. Steelcraft Manufacturing Co.
11. Trussbilt, Inc.
12. Williamsburg Steel Products Co.
13. Stiles Custom Metal, Inc.

B. Basic Metal Material:

1. ASTM A366-91; sheet steel, cold-rolled, stretcher level.
2. ASTM A167-91, Type 316 stainless steel.

C. Hollow Metal Frames:

1. Products of hollow metal door manufacturer.
2. SDI 100, except as modified herein.

3. Frames for Doors: 16-gauge for interior and 14-gauge for exterior, welded type, of cross-section shown.
4. Prepare floor and wall anchors, reinforcement, and cutouts for hardware to meet requirements of SDI 107.
5. Finished size, shape, and profile of frame members as shown.
6. Concealed fasteners or welding are preferred to through-the-face fasteners.
7. Identification: Stamp opening number, as shown on Drawings, on center hinge reinforcement of each frame.

D. Hollow Metal Doors: SDI 100, except as modified herein. SDI 107 and ANSI A115 to receive hardware specified in Door and Hardware Schedule.

1. Exterior:
   a. Flush Panel Doors: 16-gauge, Grade III, Model 1, with honeycomb or polyurethane core.
   b. Double Doors: Overlapping astragals for active leaf, except as noted or detailed otherwise.
   c. Flush end closure at top of doors.

E. Door louvers manufacturer's standard fixed blade, double-zee louver, minimum 16-gauge with vertical slat reinforcement at 12-inch centers, and minimum 30 percent free area, factory installed, size as shown. Provide exterior doors with aluminum 18- to 14-mesh, 0.0123-inch diameter, 5056 clad insect screen with frame to match louver.

F. Door Glazing:

1. Furnish with formed glazing strips of snap-in type (no screws allowed) to permit selection of secure side in field.
2. Laminated Safety Glass (S.G.): ASTM C1172-91, 7-mm minimum total thickness, consisting of two lights of float glass, bonded to minimum 0.030-inch high-resistant plastic interlayer, meeting 16 CFR 1201, CI or CII, as applicable, and ANSI Z97.1-84.

2.2 MISCELLANEOUS ITEMS FOR DOORS

A. Filler or Transom Panels: Provide of same construction and finish as door to include fire-resistive label and sound-retardant construction. Rabbet joint between metal door and filler panel for 1/2-inch minimum overlap.

B. Provide manufacturer's standard core filler, anchors, fasteners, and other ancillary items.

2.3 FACTORY FINISHING REQUIREMENTS FOR DOORS

A. Hollow Metal Door and Frame Finish:

1. Phosphate treated for paint adhesion.
2. Galvanized with A60 or G60 zinc coating in accordance with ASTM A525-91a (Wipe Coat galvanized coating is not acceptable).

3. One shop coat of baked-on rust-inhibiting prime coating compatible with finish coating as shown and as specified in Section 09900, PAINTING.
4. Stainless Steel: ASTM A480-91a, No. 3 or No. 4.

2.4 ACCESS PANELS

A. 16-gauge, minimum, bonderized frame with formed edges and mitered corners.

B. 20-gauge, minimum, bonderized flat, steel door panel.

C. Provide keylocks, constant-force closure springs, and an interior release handle.

D. Rating shall be U.L. or Warnock Hersey, minimum 1-hour rating for use in combustible ceiling systems.

E. Size: 22-inch by 30-inch minimum clear opening width.

F. Manufacturers:

1. Bar-Co., Enterprise, AL.
2. W. L. Industries, Bloomington, MN.
3. Milcor, Lima, OH.

PART 3 EXECUTION

3.1 INSTALLATION

A. Frames:

1. Installation:
   a. Maintain scheduled dimensions, hold head level, and maintain jambs plumb and square.
   b. Secure anchorages and connections to adjacent construction.
   c. Wherever possible, leave frame spreader bars intact until frames are set perfectly square and plumb and anchors are securely attached.
2. Hollow Metal Frames: SDI 105.

B. Doors:

1. Hollow Metal Doors: SDI 100.
2. Hardware: In accordance with manufacturer's templates and instructions.
   a. Adjust operable parts for correct function.
   b. Remove hardware, with exception of prime coated items, tag, box, and reinstall after finish paint work is completed.
3. Labeled Doors: NFPA Pamphlet No. 80.

C. Glazing: Follow recommendations of FGMA "Glazing Sealing Systems Manual."

3.2 ACCESS PANELS

A. Follow manufacturer's instructions.

B. Provide and install accessory items as necessary for a complete operating system.

3.3 FIELD PAINTING

A. Where prime coat has been damaged, sand smooth and touch up with same primer as applied at shop.

1. Remove rust before painting.
2. Touch Up: Not obvious.
3. Perform immediately after door and frame installation.

3.4 PROTECTION

A. Protect installed doors and frames against damage from other construction work.

3.5 SCHEDULES

A. For tabulation of hollow metal door and frame characteristics, such as size, type, detail, and finish hardware requirements, see DOOR AND HARDWARE SCHEDULE on Drawings.

END OF SECTION

SECTION 08710
DOOR HARDWARE

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Product Data: Manufacturers' literature for each item of finish hardware required herein, clearly marked.
2. Finish Hardware Schedule: Furnish complete and detailed schedule, show product items, numbers, and finishes for all hardware for each separate opening.
3. Special Tools: Provide listing and description of usage.

B. Quality Control Submittals:

1. Operations and Maintenance Manuals.
2. Manufacturer's Field Service Report.
3. Certification of Hardware Consultant.
4. Manufacturer's Certificate of Proper Installation.

1.2 QUALITY ASSURANCE

A. Qualifications of Supplier: A recognized supplier of architectural finish hardware, with warehousing facilities, who has been furnishing hardware in the vicinity of the Project for not less than 5 years, and who is, or who employs, an architectural hardware consultant.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Provide secure storage for all finish hardware until installation is made.

B. Before delivery, clearly identify and tag each item of hardware with respect to specified description and location of installation.

1.4 SPECIAL TOOLS

A. Two sets of special tools for installation and maintenance of hardware.

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide end products of one manufacturer for each product in order to achieve standardization for appearance, maintenance, and replacement.

B. Finishes: BHMA 1301.

2.2 FASTENERS

A. Stainless steel.

2.3 BUTT HINGES

A. ANSI A156.1-88 (BHMA 101).

B. Quantity per Door Leaf (Minimum):

Door Height	Hinges
Up to 5'-0"	1 pair
5'-1" to 7'-7"	1-1/2 pair
7'-7" to 10'-0"	2 pairs
10'-1" to 12'-6"	2-1/2 pairs

C. Hinge Height (Minimum):

Door Width	Hinge Height
Up to 3'-0"	4-1/2"
3'-1" to 4'-0"	5"
Over 4'-0"	6"

D. Width: Minimum for clearance of trim and 180-degree swing.

E. Exterior Hinges: Nonremoveable pin.

F. Joint Tolerance: 0.012-inch maximum, gauged in CLOSED position.

G. Finish: Satin chromium-plated brass or bronze No. 626.

H. Types and Manufacturers:

No.	Type Description	Stanley	Mc-Kinney	Lawrence	ANSI/ BHMA
H4	Extra heavy-weight, four ball races, full mortise, stainless steel	FBB199	T4B3386	BB5151-A	A5111
H7	Electric hinge, single pole, double throw switch, concealed wires, concealed switch, 24V ac/dc, 0.20 amps, with U.L. listed junction box and mortar shield	CE FBB199 and JB-2	TA/TB2314XCS	or equal	A5411

2.4 LOCKS AND LATCH SETS

A. Mortise Locks: ANSI A156.13-87, Series 1000, Grade 1 and A115.1-90.

1. Materials: Brass or stainless steel.
2. Trim: Wrought or forged lever handles and roses.
3. Core Cylinders: Interchangeable, removable; minimum of six pins.
4. Bolt Throw: 5/8-inch minimum.
5. Backset: 2-3/4 inches.
6. Manufacturers and Products:
   a. Sargent; 8100 Line.
   b. Schlage; 03.

B. Tactile Warning: Knurl knob backs, handles, and crossbars for touch identification; ANSI A117.1-86, Section 4.29.3.

C. Finish: Satin chromium-plated No. 626.

D. Types and Manufacturers:

No.	Type Description	Sargent	Schlage	ANSI/ BHMA
L1	Mortise entrance lock with lever handle	8145-LNH	L9456P-03	F12, F13
L2	Provide cylinder for keying to other locks			
L3	Dummy trim	8194-LNH	L9176	

E. Keying:

1. Lock Cylinders: Operate by a grand master key system that allows for future expansion.
2. Keylocks: Key new locks into existing master key system. As directed by OWNER.
3. Keys: Two per lock; tag with schedule information.
4. Master Keys: Four; send by registered mail to RESIDENT ENGINEER.

2.5 CONSTRUCTION KEY SYSTEM

A. Removable construction core system for locks.

B. See lock manufacturer's services under Part 3, EXECUTION.

2.6 CLOSERS

A. ANSI A156.4-86.

B. Size closers in accordance with manufacturer's standards. Mount closers on interior or push side of doors. On pair of doors provide closer on active leaf only, unless noted otherwise.

C. Finish: Satin chromium-plated No. 626.

D. Types and Manufacturers:

No.	Type Description	LCN	Sargent	ANSI/ BHMA
C4	Parallel arm with integral stop and hold-open	4110-Cush-n-Stop Series	351-PSH Series	C02021

2.7 STOPS AND HOLDERS

A. ANSI A156.16-89.

B. Machine Screws: In threaded anchors at concrete or masonry.

C. Self-Tapping Screws: At stud partitions, wood, or metal mountings.

D. Finish: Satin chromium-plated No. 626.

E. Types and Manufacturers for Each Leaf:

No.	Type Description	BBW or GJ	Baldwin	ANSI/ BHMA
S7	Heavy-duty overhead stop	GJ79HDS		

2.8 BOLTS

A. ANSI A156.16-89.

B. Finish: Bright nickel No. 645.

C. Types and Manufacturers:

No.	Type Description	GJ	Stanley	Lawrence	ANSI/ BHMA
B1	Top and bottom automatic flush bolts and coordinator and dustproof strike	FB9A and FB7A, COR Series and DP-1			L04201

2.9 THRESHOLDS

A. Thresholds: One-piece full width of opening; extend beyond jamb where indicated.

B. Provide with stainless steel machine screws in threaded expansion anchors at concrete.

C. Finish: Mill finish, unless indicated otherwise.

D. Types and Manufacturers:

No.	Type Description	Pemko	Reese
T1	Saddle (smooth, 4")	270A	S405A

2.10 WEATHERSTRIP

A. Finish: Dark bronze color hard-coat anodized aluminum, unless indicated otherwise.

B. Seal Types and Manufacturers:

No.	Type Description	Pemko	Reese
W1	Rubber or vinyl bulb at jambs and head.	S88TAN	797W
	Astragal	356AV	275A
	Door shoe	216AV	DB595A
	Rain drip	346C	R201A

2.11 TEMPLATES

A. Fabricate to template hardware applied to metal doors and frames.

B. Ensure that required templates are furnished to the various manufacturers for fabrication purposes.

C. Templates: Make available not more than 10 days after receipt of approved Hardware Schedule.

2.12 EXIT DOORS

A. Exit Doors: Always openable from the inside by the simple turn of a knob or push on a panic bar without use of a key or any special knowledge or effort, to include each leaf of door pairs.

PART 3 EXECUTION

3.1 INSTALLATION

A. In accordance with manufacturer's written instructions.

B. Make Work neat and secure, develop full strength of components, and provide proper function.

C. Prevent marring, scratching, or otherwise damaging adjacent finishes during hardware installation.

D. Latchbolts: Install to engage in strikes automatically, whether activated by closers or manually.

1. In no case shall additional manual pressure be required to engage latchbolt in strike.

E. Stops and Holders: Set to allow doors to open as far as possible.

F. Wall Mounted Hardware: Install over solid structural backing or solid blocking in hollow walls.

G. Thresholds:

1. Cope ends neatly to profile of jamb.
2. Set in sealant and seal ends to jambs.

H. Hardware: Adjust for easy, noise-free operation.

I. Replace damaged hardware items.

3.2 MOUNTING DIMENSIONS

A. Standard Door Hardware Locations: As recommended and published by the Door and Hardware Institute, except as noted or detailed otherwise.

3.3 PROTECTION

A. Cover and protect exposed surfaces of hardware during installation and until Substantial Completion.

B. Fit, dismantle, and reinstall finish hardware as required for finish painting work.

C. Protect and prevent staining of hardware during construction in accordance with manufacturer's recommendations.

D. Remove protective measures and permanent lock cylinders installed prior to final cleaning.

3.4 HARDWARE SCHEDULE

A. The Hardware Schedule on the Drawings is a guide to functional requirements of each opening.

B. Provide finish hardware as scheduled.

END OF SECTION

SECTION 09250
CEMENT BOARD

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings: Manufacturer's list of items and materials proposed for use, with descriptive literature for each system used.

1.2 QUALITY ASSURANCE

A. General: Regardless of the minimum specifications herein, utilize materials and applications recommended by the manufacturer.

B. Applicator's Qualifications: Use only workers regularly employed in this type of work who can show experience in the application of similar materials and the specific systems specified.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver fire-rated materials bearing testing agency label and required fire classification numbers.

B. Storage:

1. Store materials inside, under cover, stacked flat, off floor.
2. Stack cement board so that long lengths are not over short lengths.
3. Store adhesives and finishing compounds in dry areas; protect against freezing at all times.

1.4 ENVIRONMENTAL CONDITIONS

A. Temperature: In areas receiving cement board installation, maintain temperature range between 55 and 70 degrees F for 24 hours before, during, and after board and joint treatment application.

B. Ventilation:

1. Provide ventilation during and following adhesives and joint treatment applications.
2. Use temporary air circulators in enclosed areas lacking natural ventilation.
3. Keep air circulation at a minimum level during skim coat application to avoid excessive drying.
4. Under slow drying conditions, allow additional drying time between coats of joint treatment.
5. Protect installed materials from drafts of ambient air during hot, dry weather.

PART 2 PRODUCTS

2.1 GENERAL

A. All products shall be same manufacturer's products or approved for use.

2.2 CEMENT BOARD

A. 1/2-inch nominal, aggregated portland cement panel reinforced with vinyl-coated, woven fiberglass mesh embedded in both surfaces, with the following minimum characteristics:

1. United States Gypsum; Durock.
2. Or equal.

B. Fasteners:

1. Screws: 1-1/4 inch, Type S-12, for 14- to 20-gauge steel framing.

C. Joint Reinforcement: 4 inches wide, glass fiber, open weave tape, as recommended by manufacturer.

D. Joint Compound: Chemically curing, polyindurate type material, as recommended by manufacturer.

1. USG, Durabond.
2. Or equal.

2.3 SPRAY TEXTURE

A. Interior Walls:

1. United States Gypsum; USG spray texture.
2. Or equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Inspect surfaces to receive cement board and related materials before beginning work and report to RESIDENT ENGINEER any defects in such work which will adversely affect the quality of work specified herein.

3.2 PREPARATION

A. General: Provide, install, and maintain necessary scaffold, staging, trestles, planking, and temporary heating, lighting, and ventilation as necessary for the duration of the gypsum board work.

B. Protection: Protect work of other trades.

C. Coordination:

1. Coordinate work with that of other trades. Check specifications and drawings of other trades to determine parts of work requiring coordination.
2. Cut and repair gypsum board systems for installation of omitted work.

D. Surface Preparation: Repair *defective* surfaces prior to starting work. Prepare as specified for application of specific materials.

3.3 INSTALLATION OF CEMENT BOARD AND SKIM COAT FINISH

A. Follow manufacturer's printed instructions for erection, cutting, attachments, joint treatment, and finish.

B. Verify that framing is installed at maximum 16 inches OC, and that necessary blocking to support all fixtures and accessories has been installed. Where backing plates or straps are used, space out from framing to ensure a smooth finish application. Do not proceed until defects are corrected and are acceptable.

C. Precut boards to required sizes and make necessary cutouts. Fasten with the appropriate fasteners. Space fasteners 8 inches OC, maximum, or as directed by manufacturer. Place fasteners in field of board and then work outwards. Perimeter fasteners shall be at least 3/8-inch and no more than 5/8-inch from edge. Fit ends of boards closely but not forced together. Maintain 1/4-inch spacing between edge of board and fixture. Apply 4-inch glass fiber tape over joints and corners embedded with joint compound.

D. Do not overlap tape. After joint taping has dried, coat entire surface with skim coat of specified joint compound to obtain a smooth surface.

E. Apply texture coating to achieve an orange peal finish after skim coat has dried.

3.4 SPRAY TEXTURE

A. Application:

1. Apply wall surfaces following manufacturer's printed directions for a medium texture.
2. When surfaces are prepared and dry, apply sealer and allow to dry. Mix texture finish material as directed by manufacturer.
3. Use spray equipment of a size and type to assure acceptable results.
4. Apply by spray only at a coverage rate not to exceed 8 square feet per pound and in accordance with directions printed on container. Apply material to blend uniformly and cover fully without starved spots or other evidence of thin application. Provide uniform texture without application patterns.

3.5 ADJUST AND CLEAN

A. Clean: Remove droppings or texture overspray from walls, windows, and floor, leaving room clean for following trades.

B. Ridging:

1. Do not repair ridging until condition has fully developed, approximately 6 months after installation or one heating season.
   a. Sand ridges to reinforcing tape without cutting through tape.
   b. Fill concave areas on both sides of ridge with topping compound.
   c. After fill is dry, blend in topping compound over repaired area.
2. Fill cracks with compound and finish smooth and flush.

END OF SECTION

SECTION 09500
ACOUSTICAL TREATMENT

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Profile, gauge, and location of panels.
2. Location and type of fasteners and subgirts.
3. Location, gauge, shape, and method of attachment of all trim.
4. All other items pertinent to fabrication and installation.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Upon delivery to the Project site, inspect materials for damage, dampness, and wet storage stains.
2. Do not uncrate materials until ready for use.

B. Storage:

1. Store panels on edge, positioned to allow moisture to run off rather than accumulate on the faces.
2. Separate so air can circulate around every surface.

C. Protect products from weather, abuse, defacement, and damage.

PART 2 PRODUCTS

2.1 ACOUSTICAL PANEL SYSTEM

A. Manufacturer: Eckoustic Functional Panels, as manufactured by Eckel Industries, Inc., Cambridge, MA.

B. Sound Absorption: When tested in accordance with ASTM C423-90a, sound absorption as expressed in Sabins for a standard 30-inch by 96-inch panel with 1-mil flame guard polyethylene-wrapped acoustic filler:

125-Hz	6.9
250-Hz	17.8
500-Hz	28.4
1,000-Hz	27.3
2,000-Hz	25.5
4,000-Hz	27.9

C. Panel Facings:

1. Fabricated of 22-gauge zinc-coated steel, perforated with 3/32-inch holes on 5/32-inch staggered centers, V-ridged on 6-inch centers to a depth of 3/4 inch and suitably stiffened with transverse framing members.
2. Two framing members on panels up to 8 feet in length.
3. Three framing members to all panels over 8 feet in length.
4. Framing Members: Manufactured from a minimum of 20-gauge zinc-coated steel. Furnish each framing member with two 1/4-inch, 20-blind threaded inserts for attachment of panel to mounting bracket.
5. Trim: As detailed on Drawings, furnished by manufacturer to match finish of panels.
6. Fasteners: Furnished by the manufacturer for type of installation detailed on Drawings.
7. Insulation: Semirigid rectangular boards of fibrous glass insulation having a density of not less than 1.5 pounds per cubic foot and conforming to ASTM C612-83, Class 4, 2 inches thick by 30 inches wide.

2.2 SPRAY-ON INSULATION

A. Cellulose Fiber:

1. Maximum Thermal Conductivity ("K") Value: 0.22.
2. Flame Spread: 25 or less when tested per ASTM E84-91.
3. Fuel Contribution: 10 or less.
4. Smoke Developed Rating: 0.
5. Color: White with minimum light reflectance of 70 percent where exposed.
6. Manufacturers and Products:
   a. International Cellulose Corp.; K-13.
   b. ThermoCon; Spray-Tec ThermoCon spray-on insulation.

2.3 SOUND SCREEN

A. Description: 2-inch thick, quilted sound screen consisting of flexible, fire safe (ASTM E84-84a) fiberglass blankets laminated to both sides of a 3/32-inch vinyl septum and covered each side with a nonporous, aluminum-vinyl coated, fiberglass cloth that is quilted with high-strength polyester thread in a lock-stitch pattern, with edges bound and necessary grommets installed.

B. Color: Grey.

C. Size: Custom.

D. Accessories: Provide track, rollers, hooks, and wall attachment/supports for track.

E. Sound Absorption; Coefficient for each side shall be minimum:

125-Hz	0.38
250-Hz	0.89
500-Hz	0.82
1,000-Hz	0.76
2,000-Hz	0.53
4,000-Hz	0.35

F. Manufacturer: The Proudfoot Company, Inc., Botsford, CT, Noisemaster Quilted Sound Screen, or equal.

PART 3 EXECUTION

3.1 ERECTION OF PANEL SYSTEMS

A. Provide a minimum of four support brackets or anchors for each panel.

B. In accordance with the manufacturer's current printed instructions.

3.2 SPRAY-ON INSULATION

A. Prepare surfaces to receive spray-on insulation free of dirt, grease, oil, loose paint, excessive rust scale, or other foreign material which would prevent adequate adhesion.

1. Do not proceed with insulation application until unsatisfactory conditions are corrected.

B. Ambient Temperature: Between 40 and 155 degrees F throughout application process.

C. Application: Mix, apply, and finish spray-on insulation in accordance with manufacturer's specifications and instructions for monolithic blanket of uniform texture.

1. Insulation Blanket Thickness: Minimum 2 inches.

3.3 SOUND SCREEN

A. Provide tracks, roller-hooks, wall and ceiling attachments, and supports necessary for a double track, movable, slide-by installation as shown on Drawings.

B. Follow manufacturer's instructions.

3.4 FINISHES

A. Exposed Surfaces: Free of dents, scratches, abrasions, or other visible defects.

END OF SECTION

SECTION 09900
PAINTING

PART 1 GENERAL

1.1 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils, or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HC1: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness.
5. MDFTPC: Minimum Dry Film Thickness Per Coat.
6. Mil: Thousandth of an inch.
7. MIL-P: Military Specification–Paint.
8. PSDS: Paint System Data Sheet.
9. SFPG: Square Feet Per Gallon.
10. SFPGPC: Square Feet Per Gallon Per Coat.
11. SP: Surface Preparation.

1.2 SUBMITTALS

A. Shop Drawings:

1. Data Sheets:
   a. For each paint system, furnish a Paint System Data Sheet (PSDS), the manufacturer's Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system. The PSDS form is appended to the end of this section.
   b. Submit required information on a system-by-system basis.
   c. Furnish copies of paint system submittals to the coating applicator.
   d. Indiscriminate submittal of manufacturer's literature only is not acceptable.

B. Samples:

1. Unless otherwise specified, before painting work is started, prepare minimum 8- by 10-inch samples with type of paint and application specified on similar substrate to which paint is to be applied.
2. Furnish additional samples as required until colors, finishes, and textures are approved.
3. Approved samples to be the quality standard for final finishes.

C. Quality Control Submittals:

1. If the manufacturer of finish coating differs from that of shop primer, provide both manufacturers' written confirmation that materials are compatible.
2. Manufacturer's written instructions and special details for applying each type of paint.

D. Contract Closeout Submittals: Special guarantee.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Applicator's Experience: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
2. Perform surface preparation and painting in accordance with recommendations of the following:
   a. Paint manufacturer's instructions.
   b. SSPC-PA Guide No. 3, Guide to Safety in Paint Applications.
   c. Federal, state, and local agencies having jurisdiction.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.

B. Shipping:

1. Where precoated items are to be shipped to the site, protect coating from damage. Batten coated items to prevent abrasion.
2. Use nonmetallic or padded slings and straps in handling.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not apply paint in temperatures outside of manufacturer's recommended maximum or minimum allowable, or in dust, smoke-laden atmosphere, damp or humid weather.

B. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.

1.6 SPECIAL GUARANTEE

A. Furnish manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as special guarantee. Special guarantee

shall provide for correction, or at the option of the OWNER, removal and replacement of Work specified in this Specification section found *defective* during a period of 2 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of *defective* Work as specified in paragraph 13.12 of the General Conditions.

B. CONTRACTOR and paint manufacturer shall jointly and severally furnish guarantee.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Coatings Manufacturers Code A (Able to supply most heavy-duty industrial coatings and architectural paints):

1. Ameron Protective Coatings, Brea, CA.
2. Carboline Coatings Co., St. Louis, MO.
3. Devoe & Raynolds Co., Louisville, KY.
4. DuPont Chemical Co., Wilmington, DE.
5. Hempel/Reliance Paints, Houston, TX.
6. Keeler and Long, Inc., Watertown, CT.
7. Master Builders, Inc., Cleveland, OH.
8. Plas-Chem Coatings, St. Louis, MO.
9. Porter-International, Louisville, KY.
10. Sigma Coatings, Inc., Harvey, LA.
11. Tnemec Coatings, Kansas City, MO.
12. Valspar Corp., Azusa, CA.
13. Wisconsin Protective Coatings, Green Bay, WI.

B. Paint Manufacturers Code B (Able to supply most architectural and institutional paints):

1. Ameritone, Long Beach, CA.
2. Benjamin Moore Paints, New York, NY.
3. Detroit Graphite Co., Rockford, IL.
4. Fuller/O'Brien Paint Co., San Francisco, CA.
5. Pittsburgh Paints, Pittsburgh, PA.
6. Pratt and Lambert, Inc., Buffalo, NY.
7. Rustoleum Corp., Evanston, IL.
8. Samuel Cabot, Inc., Boston, MA.
9. Sherwin Williams, Cleveland, OH.
10. Textured Coatings of America, Los Angeles, CA.
11. Thoro Systems, Miami, FL.

C. Specialty Manufacturers Code C:

1. Darworth Co., Avon, CT.
2. Jasco Chemical Co., Mountain View, CA.
3. McCloskey Varnish Co., Philadelphia, PA.
4. Olympic Stain & Varnish, Seattle, WA.

D. Fusion Bonded Coating Applicators Code E:

1. Industrial Operation, Phoenix, AZ.
2. Waterworks Manufacturing, Marysville, CA.
3. Waterspecialties, Porterville, CA.

2.2 MATERIALS

A. General:

1. Material Quality: Manufacturer's highest quality products and suitable for intended service.
2. Materials Including Primer and Finish Coats: Produced by same manufacturer.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by manufacturer of the particular coating.

B. Products are listed below according to their approximate order of appearance in the systems. The letter designating the manufacturer code refers to Article MANUFACTURERS.

Product	Definition	Manufacturer Code
Coal-Tar Epoxy	Amine or phenolic epoxy type; 70 percent volume solids minimum, suitable for immersion service	A
Organic Zinc Rich Primer	Converted epoxy, epoxy/phenolic or urethane type, minimum 10 pounds metallic zinc content per gallon	A
Rust-Inhibitive Primer	Single-package steel primers with anticorrosive pigment loading	A,B
Alkyd Enamel	Optimum quality, gloss finish, medium long oil	A,B
Wash Primer	Vinyl butyral acid	A
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish	A
Epoxy Primer	Polyamide, anticorrosive, converted epoxy primer containing rust-inhibitive pigments	A
Acrylic/Latex Finish	Semi-gloss, single-component	A,B

Product	Definition	Manufacturer Code
Bituminous Paint	Single-component, coal-tar pitch based	A
Block Filler	Primer-sealer designed for rough masonry surfaces, 100 percent acrylic emulsion	A,B
Alkyd (Semigloss)	Semigloss alkyd	A,B
Acrylic Latex (Flat)	Flat latex	A,B
Fusion Bonded Coating	100 percent solids, thermosetting, fusion bonded, dry powder epoxy or polyurethane resin, suitable for the intended service	E
Fusion Bonded, TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating; No. 62-4621-4830-5 as manufactured by 3M Co., St. Paul, MN; or open gear grease as supplied by McMaster-Carr Co., Elmhurst, IL; RL 736 manufactured by Amrep, Marietta, GA	E

2.3 MIXING

A. Multiple-Component Coatings:

1. Prepare using the contents of the container for each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

2.4 COLORS

A. Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at the site.

B. Colors shall be as noted in the Application Schedule. Colors not noted shall be as selected by the RESIDENT ENGINEER.

PART 3 EXECUTION

3.1 EXAMINATION

A. Surface Preparation Verifications:

1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

3.2 PREPARATION

A. Shop Blast Cleaning:

1. Structural steel, metal doors and frames, metal louvers, and similar items may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternate to shop blast cleaning.

B. Field Abrasive Blasting: Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed.

C. Protection of Items not to be Painted:

1. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.
2. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
3. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
4. Mask openings in motors to prevent paint and other materials from entering the motors.

3.3 PREPARATION OF SURFACES

A. Metal Surfaces:

1. Where indicated, meet requirements of the following SSPC Specifications:
   a. Solvent Cleaning: SP 1-82.
   b. Hand Tool Cleaning: SP 2-89.
   c. Power Tool Cleaning: SP 3-89.
   d. White Metal Blast Cleaning: SP 5-91.
   e. Commercial Blast Cleaning: SP 6-91.
   f. Brush-Off Blast Cleaning: SP 7-91.
   g. Pickling: SP 8-91.
   h. Near-White Blast Cleaning: SP 10-91.
   i. Power Tool Cleaning to Bare Metal: SP 11-91.

2. The words "solvent cleaning", "hand tool cleaning", "wire brushing", and "blast cleaning", or similar words of equal intent in these Specifications or in paint manufacturer's specifications refer to the applicable SSPC Specifications.
3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply.
4. Hand tool clean areas that cannot be cleaned by power tool cleaning.
5. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
6. Welds and Adjacent Areas:
   a. Prepare such that there is:
      1) No undercutting or reverse ridges on weld bead.
      2) No weld spatter on or adjacent to weld or any other area to be painted.
      3) No sharp peaks or ridges along weld bead.
   b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
7. Preblast Cleaning Requirements:
   a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
   b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
   c. Clean small isolated areas as above or solvent clean with suitable solvents and clean cloths.
8. Blast Cleaning Requirements:
   a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
   b. Select type and size of abrasive to produce a surface profile that meets coating manufacturer's recommendations for particular primer to be used.
   c. Use only dry blast cleaning methods.
   d. Do not reuse abrasive, except for designed recyclable systems.
   e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
9. Post-Blast Cleaning and Other Cleaning Requirements:
   a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
   b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

B. Plastic Surfaces:

1. Hand sand plastic surfaces to be coated with a medium grit sandpaper to provide tooth for the coating system.
2. Large areas may be power sanded or brushoff blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

C. Masonry Surfaces:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
   a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
   b. Brushoff blasting.
   c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair the intended finished appearance.
7. Clear Coated Masonry Surfaces: Free of discolorations and uniform in texture after cleaning.

3.4 SURFACE CLEANING METHODS

A. Brushoff Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC-SP 7-91, Brushoff Blast Cleaning.
2. Abrasive: Either wet or dry blasting sand, grit, or nut shell.
3. Select various surface preparation parameters such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. RESIDENT ENGINEER will approve acceptable trial blast cleaned area and will use area as a representative sample of surface preparation.
6. Repair or replace surfaces damaged by blast cleaning.

B. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or

similar materials and methods which involve a solvent or cleaning action.

2. Meets requirements of SSPC-SP 1-82.

3.5 APPLICATION

A. General:

1. The intention of these Specifications is for new, interior and exterior metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Prime coat structural steel surfaces. Exterior concrete and masonry surfaces will not be painted unless specifically indicated.
2. Apply coatings in accordance with these Specifications and the paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
3. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
4. Sand wood and metal lightly between coats to achieve required finish.
5. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
6. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
7. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
8. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
9. Keep paint materials sealed when not in use.
10. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that the required number of coats have been applied.

B. Shop Primed and Factory Finished Surfaces:

1. Prepare surfaces and spot prime using specified primer.
2. Apply mist coat of primer, 1-mil dry film thickness.
3. After welding, prepare and prime holdback areas as required for paint system. Apply primer in accordance with manufacturer's instructions.

C. Film Thickness:

1. Number of Coats: Minimum required without regard to coating thickness. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Maximum film build per coat shall not exceed coating manufacturer's recommendations.
3. Visually inspect concrete, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.

4. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.

D. Porous Surfaces, Such As Concrete, Masonry:

1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface defects.
2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
   a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
3. Surfaces Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

E. Damaged Coatings, Pinholes, and Holidays:

1. Feather edges and repair in accordance with recommendations of paint manufacturer.
2. Apply finish coats, including touchup and damage-repair coats in a manner which will present a uniform texture and color-matched appearance.

F. Unsatisfactory Application:

1. If item has an improper finish color, or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
3. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
4. Repair defects in accordance with written recommendations of coating manufacturer.
5. Leave staging and lighting up until RESIDENT ENGINEER has inspected surface or coating. Replace staging removed prior to approval by RESIDENT ENGINEER. Provide additional staging and lighting as requested by RESIDENT ENGINEER.

3.6 FIELD QUALITY CONTROL

A. Testing Gauges:

1. Provide a magnetic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA, Mikrotest.
2. Provide an electrical holiday detector, low voltage, wet sponge type to test finish coat, except zinc primer, high-build elastomeric coatings,

and galvanizing, for holidays and discontinuities as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.

3. Provide a high voltage holiday detector for elastomeric coatings in excess of 25 mils dry film thickness. Unit to be as recommended by the coating manufacturer.

3.7 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.

B. Upon completion of the Work, remove staging, scaffolding, and containers from the site or destroy in a legal manner.

C. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.8 COATING SYSTEMS

A. System No. 2 Concrete Embeded Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP SP 5)	Polyamide, Anticorrosive Epoxy Primer	1 coat, 2.5 MDFT
	Coal-Tar Epoxy	2 coats, 16 MDFT

B. System No. 5 Exposed Metal–Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10-91)	Polyamide, Anticorrosive Epoxy Primer	1 coat, 2.5 MDFT
	Polyurethane Enamel	2 coats, 3 MDFT

C. System No. 5A Exposed Metal–Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
System No. 10		
	Polyurethane Enamel	2 coats, 3 MDFT

D. System No. 8 Buried Metal—General:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast or Centrifugal Wheel Blast (SP 10-91)	Standard Hot Coal-Tar Enamel -OR- Coal-Tar Epoxy -OR- Tape Coat System	AWWA C203-86 AWWA C210-84 AWWA C214-83
	For Acidic Soil, Brackish Water High Bacteria: Hot Coal-Tar, Double Felt	AWWA C203-86, App. A, Sec. A1.5
	For Highly Abrasive Soil, Brackish Water: Hot Coal-Tar, Fibrous Glass -OR- Tape Coat System	AWWA C203-86, App. A, Sec. A1.5 AWWA C214-83 with Double Outer Wrap

E. System No. 10 Galvanized Metal Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2) or Power Tool (SP 3)	Wash Primer or Coating Manufacturer's Recommendation	1 coat, 0.4 MDFT

F. System No. 11 Galvanized Metal Repair:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1-82) Followed by Hand Tool (SP 2-89), Power Tool (SP 3-89), or Brushoff Blast (SP 7-91)	Organic Zinc Rich Primer	1 coat, 3 MDFT

G. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1-82)	Wash Primer	1 coat, 0.4 MDFT
	Bituminous Paint	1 coat, 10 MDFT

H. System No. 29 Fusion Bonded Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10-91) or Acid Pickling (SP 8-91)	Fusion Bonded 100 percent Solids Epoxy or Polyurethane	1 or 2 coats, 7 MDFT

I. System No. 29A Fusion Bonded, Steel Dowel Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10-91) or Acid Pickling (SP 8-91)	Fusion Bonded 100 percent Solids Epoxy	1 or 2 coats, 7 MDFT
TFE Lube, Shop Applied; Grease Lube Alternative, Field Applied Just Prior to Installation	TFE Lube or Grease Lube	1 coat, as required

J. System No. 106 Galvanized Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1-82) Followed By Hand Tool (SP 2-89) or Power Tool (SP 3-89)	Wash Primer or Coating Manufacturer's Recommendation	1 coat, 0.4 MDFT
	Alkyd Enamel (Semigloss)	2 coats, 4 MDFT

K. System No. 107 Metal Trim and Structural Steel:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 6-91) -OR- Pickle (SP 8-91)	Rust-Inhibitive Primer	1 coat, 2 MDFT
Solvent Clean (SP1-82) at Factory Primed Surfaces.	Alkyd Enamel (Semigloss)	2 coats, 4 MDFT

L. System No. 109 Concrete Masonry, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
Masonry	Block Filler	1 coat, 75 SFPG
	Acrylic Latex (Semigloss)	2 coats, 240 SFPGPC

M. System No. 115 Gypsum Wallboard and Plaster, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
	Latex Primer/Sealer	1 coat, 350 SFPG
	Acrylic/Latex (Semigloss)	2 coats, 400 SFPGPC

3.9 APPLICATION SCHEDULE

A. As shown in the Interior Finish Schedule on Drawings and in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from RESIDENT ENGINEER before starting work in question.

B. System No. 2 Concrete Embedded Metal: Use on the following items or areas:

1. Concrete embedded surfaces of metallic items, such as wall pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel.

C. System No. 5 Exposed Metal—Mildly Corrosive: Use on the following items or areas:

1. As noted in the Interior Finish Schedule on the Drawings.

2. Coffer Dam Piles and Panels: Paint color to match Aermitone IU52B, Mikado.
3. Steel security fencing at dam abutments. Paint color to match Ameritone IU52B, Mikado.
4. Security camera supports and enclosure. Paint color to match Ameritone IU52B, Mikado.

D. System No. 5A, Exposed Metal–Mildly Corrosive: Use on galvanized items or areas specified to be painted.

E. System No. 8 Buried Metal–General: Use on the following items or areas:

1. Buried, belowgrade portions of steel items, except buried stainless steel or ductile iron.

F. System No. 10 Galvanized Metal Conditioning: Use on galvanized surfaces requiring painting.

G. System No. 11 Galvanized Metal Repair: Use on the following items or areas:

1. Galvanized surfaces that are abraded, chipped, or otherwise damaged.

H. System No. 27 Aluminum and Dissmilar Metal Insulation: Use on concrete embedded aluminum surface.

I. System No. 29 Fusion Bonded Coating: Use on the following Items:

1. Stainless steel bolts with fusion bonded coating.

J. System No. 29A Fusion Bonded Steel Dowel Coating: Use on steel expansion joint dowels specified in Section 03251, EXPANSION, CONSTRUCTION, AND CONTROL JOINTS.

K. System No. 106 Galvanized Metal: Use on the following items or areas:

1. As noted in the Interior Finish Schedule on the Drawings.

L. System No. 107 Metal Trim and Structural Steel: Use on the following items or areas:

1. As noted in the Interior Finish Schedule on the Drawings.

M. System No. 109 Concrete Masonry, Semigloss: Use on the following items or areas:

1. As noted in the Interior Finish Schedule on the Drawings.

N. System No. 115 Gypsum Wallboard and Plaster, Semigloss: Use on the following item or areas:

1. As noted in the Interior Finish Schedule on the Drawings.

O. Surfaces Not Requiring Painting: Unless otherwise stated or shown, the following areas or items will not require painting or coating:

1. Concrete and masonry surfaces.
2. Reinforcing steel.
3. Nonferrous and corrosion-resistant ferrous alloys such as copper, bronze, monel, aluminum, chromium plate, atmospherically exposed weathering steel, and stainless steel, except where:
   a. Required for electrical insulation between dissimilar metals.
   b. Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.
   c. Color coding of equipment and piping is required.
4. Nonmetallic materials such as glass, PVC, wood, porcelain, and plastic (FRP) except as required for architectural painting or color coding.
5. Prefinished electrical and architectural items such as motor control centers, switchboards, switchgear, panelboards, transformers, disconnect switches (if prefinished in OSHA yellow), acoustical tile, cabinets, elevators, building louvers, and wall panels; color coding of equipment is required.
6. Nonsubmerged electrical conduits attached to unpainted concrete surfaces.
7. Cathodic protection anodes.
8. Items specified to be galvanized after fabrication, unless specified elsewhere or subject to immersion.
9. Insulated piping and insulated piping with jacket will not require exterior coating, except as required for architectural painting or color coding.

(See PSDS form attached)

END OF SECTION

PAINT SYSTEM DATA SHEET

Complete and attach manufacturer's Technical Data Sheet to this PSDS for each coating system.

Paint System Number (from Spec.):
Paint System Title (from Spec.):
Coating Supplier:
Representative:
Surface Preparation:

Paint Material (Generic)	Product Name/Number (Proprietary)	Min. Coats, Coverage

SECTION 10200
LOUVERS AND SCREENS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings: Large scale details of louvers, anchorage, and relationship to adjoining construction.

1. Manufacturer's Literature:
   a. Descriptive and performance data of louvers, including standard drawings and louver-free area.
   b. Parts list, if applicable.
   c. Installation instructions.
   d. Maintenance procedures.

B. Samples: Manufacturer's standard finishes and colors.

C. Quality Control Submittals:

1. Factory test data.
2. Certificates of AMCA ratings.

D. Contract Closeout Submittals: Special Guarantee.

1.2 SPECIAL GUARANTEE

A. Manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction, or at the option of the OWNER, removal and replacement of special fluorocarbon or baked-on finish found *defective* during a period of 2 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of *defective* Work as specified in paragraph 13.12 of the General Conditions.

PART 2 PRODUCTS

2.1 GENERAL

A. Nonacoustical louver sizes are based on 50 percent free area and 800 fpm maximum velocity through the free area. If louvers furnished do not meet these parameters, CONTRACTOR is responsible for resizing louvers and wall openings and for making all other adjustments to allow for larger openings.

B. Water Penetration Rate: No greater than 0.02 ounces per square foot.

C. Louvers: Rated and tested in accordance with AMCA Standard 500-85.

D. Furnish louvers with interior duct collars where required.

E. Furnish sill extensions where shown. Finish shall match louvers.

2.2 FIXED DRAINABLE LOUVER (TYPE DB)

A. Frame: Extruded aluminum channel, 0.081-inch thick, 4 inches deep, with interior duct collar and concealed mullions.

B. Blades: Extruded aluminum, 0.081-inch minimum thickness, 35- to 45-degree pitch angles, with integral front drain gutter, spaced 3 to 4 inches on center.

C. Pressure Loss: AMCA certified rating of no greater than 0.10-inch WC.

D. Sizes: On Drawings.

E. Screen: Inside mounted, painted aluminum, 1/2-inch mesh.

F. Manufacturers and Products:

1. Construction Specialties; Model 4157.
2. Dowco; Series DBE-4.
3. Ruskin; Model ELF-375D.

2.3 MECHANICAL EQUIPMENT SCREEN

A. Mechanical equipment screen shall be 4 inches wide by nominal 4 inches wide on center horizontal chevron-shaped extruded aluminum blades for a 100 percent vision screen. Corners shall be mitered. Material shall be 6063-T52 aluminum alloy with minimum 0.08-inch thick blades.

B. Finish:

1. Kynar 500 fluorocarbon coating.
2. Custom color as scheduled. Verify color with RESIDENT ENGINEER.

C. Accessories: Provide fasteners and intermediate supports spaced and sized to meet a 20-pound wind load.

D. Access: Provide a hinged and latching access door with padlock attachment to match and blend with the equipment screen.

2.4 ACCESSORIES

A. Anchors, Fasteners, and Flashing for All Louvers: Stainless steel or aluminum to match frames.

B. Isolation Tape: Tremco 440, 3M EC1202, or Presstite 579.6.

C. Isolation Paint: ASTM D1187-82, bituminous coating.

2.5 SOURCE QUALITY CONTROL

A. Factory Performance Tests:

1. Airflow versus pressure loss.
2. Rain penetration data.
3. Air infiltration leakage through closed operating louvers.

PART 3 EXECUTION

3.1 EXAMINATION

A. Check openings to assure that dimensions conform to Drawings.

B. Assure that openings are free of irregularities that would interfere with installation.

C. Do not install louvers until defects have been corrected.

3.2 INSTALLATION

A. Install louvers and screens as shown on reviewed Shop Drawings. Coordinate with heating or ventilation ductwork to be connected.

B. Coordinate screen location with structural supports.

C. Follow procedures in manufacturer's recommended installation instructions.

D. Installed Louvers: Capable of resisting a wind load of 20 pounds per square foot.

E. Separate aluminum from other metals with isolation tape or paint.

3.3 ADJUSTING AND CLEANING

A. Set adjustable louver blades for uniform alignment in OPEN and CLOSED positions.

B. Adjust louvers so moving parts operate smoothly.

END OF SECTION

SECTION 10520
PORTABLE FIRE AND SAFETY EQUIPMENT

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings: Manufacturer's product data for each item including sizes, ratings, UL listings, or other certifications, and mounting information.

PART 2 PRODUCTS

2.1 PORTABLE FIRE EXTINGUISHERS

A. General:

1. Conform to NFPA 10-90 for fire extinguishers.
2. Furnish fire extinguishers and cabinets from one manufacturer.
3. All Extinguishers: UL listed, charged and ready for service.

B. Multipurpose Hand Extinguisher (F. Ext):

1. Tri-class dry chemical extinguishing agent.
2. Pressurized, red enameled steel shell cylinder.
3. Activated by top squeeze handle.
4. Agent propelled through hose or opening at top of unit.
5. For use on A, B, and C class fires.
6. Minimum UL Rating: 4A-60B:C, 10-pound capacity.

2.2 ACCESSORIES

A. Fasteners: Furnish necessary screws, bolts, brackets, and other fastenings of suitable type and size to secure items of fire and safety equipment in position.

1. Metal expansion shields for machine screws at concrete and masonry.
2. Interior: Rust-resistant.

B. Brackets: For all hand extinguishers not located in cabinets, furnish heavy-duty brackets with clip-together strap for wall mounting.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install where indicated or directed and in accordance with manufacturer's recommendations.

B. Plumb and level equipment.

C. Rigidly attach cabinets and brackets to structure.

D. Provide adequate backing for mounting surfaces.

3.2 PORTABLE FIRE EXTINGUISHERS

A. Provide at locations shown or as directed by RESIDENT ENGINEER.

B. Mount hangers securely in position, following manufacturer's recommendations.

C. Top of Extinguisher: No more than 5 feet above the floor.

END OF SECTION

SECTION 11280
SLUICE GATE

PART 1 GENERAL

1.1 DEFINITIONS

A. Slenderness Ratio: The ratio of maximum unsupported stem or rod cross-section radius of gyration.

B. Self-Contained: The arrangement of gate operator, supported by gate frame, such that operating thrust loads are not applied external to gate assembly.

1.2 SUBMITTALS

A. Shop Drawings:

1. Equipment Assembly: Make, model, and weight.
2. Manufacturer's catalog information, descriptive literature, specifications, dimensional layouts, and identification of materials of construction.
3. Detailed structural and mechanical drawings showing equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work, and weights of associated equipment.
4. Gate opening and closing thrust forces that will be transmitted to support structure with operator at extreme positions and load.
5. Gate operator and stem calculations.

B. Quality Control Submittals:

1. Manufacturer's Certificate of Compliance for materials.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer's installation instructions.
4. Routine maintenance requirements prior to plant startup.
5. Manufacturer's Certificate of Proper Installation.
6. Operation and maintenance manual.

C. Contract Closeout Submittals: Service records for maintenance performed during construction.

1.3 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage following spare parts and special tools.

Item	Quantity
Stem collars for gate stems	1
Bronze lift nuts	1 of each different size

Item	Quantity
Special tools required to maintain or dismantle	1 complete set

PART 2 PRODUCTS

2.1 SLUICE GATE G-3-1

A. General:

1. Conform to AWWA C501, nonrising stem type, not self-contained.
2. Minimum Acceptable Casting Thickness for Cast Iron Components: 3/4 inch.
3. Gate Opening: 48 inches round.
4. Invert Opening Elevation: 1,128 feet.
5. Normal Operating Application: Unseating.
6. 20-inch unseating head; 0-inch seating head.
7. Mounted at 30 degrees from horizontal, left.
8. Extended flange back.

B. Wall Thimbles:

1. "F" shape, 12-inch thickness.
2. Cast iron, one-piece construction, in accordance with ASTM A126-84, Class B.
3. Cast center ring or water stop around periphery.
4. Front Flange: Machined, with tapped holes for sluice gate frame attaching studs.
5. Stamp vertical center lines of metal with word "top."
6. Furnish permanent gasket of uniform thickness or mastic between sluice gate frame and thimble.

C. Frames:

1. Cast iron one-piece construction, in accordance with ASTM A126, Class B.
2. Machine contact surfaces.
   a. Machine dovetailed grooves on front face, into which seat facings shall be driven and machined.
   b. Machine back flange to bolt directly to machined face of wall thimble cast in concrete.
3. For frames with top and bottom wedges, furnish integrally cast pads machined with keyways to receive wedge seats.
4. Where side clearance is limited, flanged frames may require mounting holes to be drilled through to front face of frame.

D. Discs:

1. Cast iron, one-piece construction with integrally cast vertical and horizontal ribs in accordance with ASTM A126 Class B.

2. Machine dovetailed grooves on seating face, into which seat facings shall be driven and machined.
3. Wedge Pads: Integrally cast on disc and machined to receive adjustable wedges.
4. Cast a heavily reinforced nut pocket integrally on vertical centerline above horizontal centerline to receive thrust nut.

E. Guides:

1. Cast iron, one-piece, in accordance with ASTM A126 Class B designed to withstand total thrust from water pressure and wedging action.
2. Machine contact surfaces.
3. Length: Sufficient to retain and support at least half disc in fully OPEN position.
4. Attach to frame with ASTM A167, Type 316 stainless steel studs; dowel to prevent relative motion between guides and frame or cast guides integrally with frame.
5. Securely attach wedge seats to machined pads on guides.

F. Wedges and Seat Facings:

1. Side wedges for all conditions. Top and bottom wedges for unseating heads as necessary to meet leakage requirements.
2. Solid cast ASTM B584-93, Alloy 865 manganese bronze.
3. Machine contact surfaces. Key to cast iron pads to prevent rotation or lateral motion.
4. Attach wedges to disc with AISI Type 316 stainless steel studs and nuts.
5. Seat Facings: ASTM B21-90e, Alloy B, shaped to fill and permanently lock in machined dovetail grooves when pneumatically impacted into place. Attaching pins and screws not permitted.

G. Stems:

1. 2-inch minimum diameter, ASTM A276-92, AISI Type 316 stainless steel.
2. Threads: Acme type with RMS surface roughness of 63 micro-inches or less on flanks for manually operated gates.
3. Couplings:
   a. Use when stems have more than one section.
   b. Same material as stem.
   c. Furnish with internal threads that transmit full thrust of stem.
   d. Hold in place on stem with bolts or keys and keyways.
   e. Same size and interchangeable.
4. Size so that ratio of unsupported stem length (L) to radius of gyration (r), both in inches, does not exceed 200.
5. Withstand in compression, without damage, thrust equal to at least 2-1/2 times rated output of hoisting mechanism, with a 40-pound effort applied to crank.

6. Cast iron, bushed stem guides, mounted on cast iron brackets, adjustable in two directions and spaced so that L/r ratio does not exceed 200.
7. Adjustable stop collar for CLOSED position.

H. Stuffing Box Assembly

1. Cast iron body, ASTM A126.
2. Gland Nut: Bronze, ASTM B584.
3. Studs and Nut: Type 304, Stainless Steel ASTM A278.
4. Graphite hemp flex packing.
5. Bushing: Brass, ASTM B16.

I. Manufacturers:

1. HydroGate Corp.
2. Rodney Hunt Co.
3. Waterman Industries, Inc.

2.2 OPERATOR

A. General:

1. Components: Withstand a minimum of 250 percent of design torque or thrust at extreme operator positions without damage.
2. Gear train and gate stem sections shall produce a self-locking drive train.
3. Lift Nuts: Internally threaded with cut or cold-rolled Acme threads corresponding to stem threading.
4. Roller Bearings: Ball-thrust or tapered above and below lift nut to support both opening and closing thrusts.
   a. Grease lubrication fittings for bearings.
   b. Input pinions with needle or ball bearings.

2.3 APPURTENANCES

A. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

B. Anchor Bolts: Type 316 stainless steel sized by equipment manufacturer at least 1/2 inch in diameter, or as shown, and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

2.4 SHOP/FACTORY FINISHING

A. Factory prepare, prime, and finish coat exposed metal surfaces with manufacturer's standard coating.

2.5 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments: Fully assemble and test sluice gates actually furnished.

1. Functional Test: Perform manufacturer's standard, test on equipment.
2. Performance Test: In accordance with AWWA C540.

PART 3 EXECUTION

3.1 INSTALLATION

A. In accordance with manufacturer's written instructions.

B. Accurately place anchor bolts using templates furnished by manufacturer and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

C. Wall Thimbles:

1. Brace internally during concrete placement.
2. Provide for installing sluice gates. Direct bolting to concrete walls is not acceptable.

D. Grease threads above stem nut prior to placing gate in operation.

3.2 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each sluice gate.

B. Performance Test:

1. Conduct on each sluice gate.
2. Perform under actual or approved simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction.
4. Adjust, realign, or modify units and retest if necessary.
5. Leakage shall not exceed 0.1 gallon per minute per foot of gate periphery under either seating or unseating head conditions.

3.3 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at site for minimum person-days listed below, travel time excluded:

1. 1/2 person-day for installation assistance and inspection.
2. 1/2 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

B. See Section 01640, MANUFACTURERS' SERVICES, and Section 01650, FACILITY STARTUP.

END OF SECTION

SECTION 11305
SUBMERSIBLE PUMPS

PART 1 GENERAL

1.1 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.2 SUBMITTALS

A. Shop Drawings:

1. Make, model, weight, and horsepower of each equipment assembly.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.
4. Power and control wiring diagrams, including terminals and numbers.
5. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
6. Factory finish system.

B. Quality Control Submittals:

1. Factory Functional and Performance Test Reports.
2. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Manufacturer's Certificate of Proper Installation.
6. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Operation and maintenance manual.

1.3 SINGLE SOURCE RESPONSIBILITY

A. Where adjustable-speed drives are required, the supplier of the pump shall be responsible for supplying a coordinated operating system complete with pump, drive, and speed controller.

PART 2 PRODUCTS

2.1 GENERAL

A. Pump equipment shall consist of pump(s) complete with motor(s), guide rails, base elbows, and anchoring brackets, as shown, power cable(s), and pump lifting cable(s). Pump metal parts that come into contact with guide rail or cable system shall be made of nonsparking materials.

B. Adjustable frequency drives shall be as specified in Section 16485, ADJUSTABLE FREQUENCY DRIVE SYSTEMS. Coordinate pump, motor, and adjustable frequency drive to provide a complete, compatible system.

2.2 MANUFACTURERS AND PRODUCTS

A. Flygt; Model C-3531CP, Impeller 1230 MT.

B. KSB; Model KRT K500-540/8410UZ.

2.3 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

2.4 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.

C. Manufacturers' Standard Motor Protection Sensors: Internal motor temperature and leakage sensors.

D. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

2.5 FACTORY FINISHING

A. Prepare and prime coat in accordance with Section 09900, PAINTING, System No. 2.

2.6 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all equipment and control panels actually furnished.

C. Factory Test Report: Include test data sheets and curve test results, certified correct by a registered professional engineer.

D. Functional Test: Perform manufacturer's standard test on equipment.

E. Performance Test:

1. Conduct on each pump.
2. Perform under actual or approved simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction.
4. Test Log: Record the following:
   a. Total head.
   b. Capacity.
   c. Horsepower requirements.
   d. Driving motor voltage and amperage measured for each phase.
   e. Throttle discharge valve to obtain pump data points on curve at 2/3, 1/3, and shutoff conditions.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

3.2 FIELD FINISHING

A. Finish coat in accordance with Section 09900, PAINTING, System No. 2.

3.3 FIELD QUALITY CONTROL

A. Functional Test: Conduct on each pump.

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
2. Flow Output: Measured by pump station instrumentation.

B. Performance Test: In accordance with Hydraulic Institute Standards.

3.4 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at site or classroom designated by OWNER, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 1/2 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for facility startup.
4. 1/2 person-day for post-startup training of OWNER's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by OWNER.

B. See Section 01640, MANUFACTURERS' SERVICES, and Section 01650, FACILITY STARTUP.

3.5 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are a part of this Specification.

1. Data Sheets:
   a. Pump.
   b. Motor.

END OF SECTION

PUMP DATA SHEET

SUBMERSIBLE PUMPS NO. P-3-1, P-3-2

Project: Rio Salado, Schedule B

Owner: City of Tempe, Department of Public Works

Service: Lakewater Return

Pump Name: Recycle Pump

Equip. Tag Number(s): P-3-1, P-3-2

Pump Mfr.: See 2.2 of this specification

Size & Type: --

Serial No.: --

Model No.: --

No. Pumps Required: 2

LIQUID	OPERATING CONDITIONS	SERVICE CONDITIONS
Name: Raw Water (Lake)	Rated Condition:	Temp (°F): Max 120 Min 30
Pumping Temperature (°F):	Flow (gpm) 11,222.5 TDH (ft) 33.5	Rel. Hum (%): Max 100 Min 5
Normal 68 Max 80 Min 50	(cfs) 25	Altitude (ft): 1,120
Specific Gravity @ 68 °F: 1.0	Secondary Condition:	■ Indoor ☐ Heated
Vapor Pressure (psia): 0.34	Flow (gpm) 4,490 TDH (ft) 25.1	☐ Outdoor ■ Unheated
Viscosity (CP) @ 68 °F: 2.10 E-5	(cfs) 10	Area Classification:
pH: 6-8	@ Speed (%) 70 min.	☐ Hazardous Classification (NFPA 70):
Corrosion/Erosion/Abrasion Caused by:	NPSH:	Class:
	NPSHA (ft) 34.2 min.	Group:
	Largest Solids Passing (in.): 4	Division:
Remarks:	Remarks: Pump to operate continuously with motor unsubmerged.	Remarks:

PERFORMANCE REQUIREMENTS (manufacturer to supply missing data)

Proposal Curve No.:

Speed (rpm): 595 min.

Efficiency (%): 80% min. @ rated condition.

Rated Power (BHP): 120 max.

NPSH Required (ft water):

3% Head Drop

Factory Testing:

■ Required ☐ Not Required

Remarks:

Equipment Tag Number(s): P-3-1, P-3-2

PUMP CONSTRUCTION DETAILS (manufacturer to supply missing data)

Pump:

☐ Single ☐ Dual

■ Heavy-Duty, Nonclog

Location:

☐ Pump Station

☐ Open Concrete Sump

☐ Vented Canned Sump

☐ Manhole Sump

■ Closed Concrete Sump

Double Mechanical Seal:

API Class Code: _____

Mftr: _____

Model No. _____

Bearings (Type/No.):

Upper: Antifriction/Grease Lubricated

Lower: Antifriction/Grease Lubricated

AFBMA Rating Life (hours): _____

Field Testing: ☐ Not Required

■ Required, Functional and Performance

Features:

☐ Alternator

☐ Vented Canned Steel or Cast Iron Tank and Cover

☐ High Temperature Construction (above 140 degrees F).

■ Guide Rails:

☐ Marine Brass

■ Type 304 SS

☐ _____

■ Lifting Chain:

■ Plastic-Bonded Steel or

■ Type 304 SS

MATERIALS (manufacturer to supply missing data)

Volute: A48-CL35B, CI

Shaft Seals: _____

Bearings:

Upper _____

Lower _____

Impeller: A48-CL35B, CI

Motor Housing: _____

ADDITIONAL REQUIREMENTS

_____

_____

_____

INDUCTION MOTOR DATA SHEET

Project: Rio Salado, Schedule B

Owner: City of Tempe, Department of Public Works

Equipment Name: Recycle Pumps

Equipment Tag Number(s): P-3-1, P-3-2

Type: Squirrel-cage induction meeting requirements of NEMA MG 1

Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark

Motor Horsepower: 120

Voltage: 460

Phase: 3

Frequency: 60 Hz

Synchronous Speed: 600 rpm

Guaranteed Minimum Efficiency at Full Load: 90.0 percent

Guaranteed Minimum Power Factor at Full Load: 63 percent

Service Factor (@ rated max. amb. temp.): ☐ 1.0 ■ 1.15

Enclosure Type: Submersible

Mounting Type: ☐ Horizontal ■ Vertical

☐ Vertical Shaft: ☐ Solid ☐ Hollow

☐ Vertical Thrust Capacity (lb): Up _____ Down _____

■ Adjustable Speed Drive: See Section 16485, ADJUSTABLE FREQUENCY, CONTROLLED SPEED, DRIVE SYSTEMS.

Operating Speed Range: 50 to 100 % of Rated Speed

☐ Thermal Protection: _____

☐ Space Heater: _____ volts, single phase

☐ Oversize main terminal (conduit) box for motors

☐ Terminal for connection of equipment grounding wire in each terminal box

Additional Motor Requirements: ☐ See Section 16405, AC INDUCTION MOTORS

Special Features:

60-foot minimum length of submersible power and control cables. Manufacturer's standard motor protection relay compatible with internal motor temperature and leakage sensors. Deliver relay to adjustable speed drive supplier and coordinate wiring so that all standard features are implemented.

SECTION 11851
RUBBER DAMS
(FOR INFORMATION ONLY)

PART 1 GENERAL

1.1 PROJECT OBJECTIVES AND CRITICAL ISSUES

A. The Rio Salado Town Lake project consists of a 2-mile long lake constructed within the Salt River that will provide recreational opportunities for the Salt River Valley. The lake will be formed by two impoundment dams, each consisting of inflatable rubber dams. The downstream impoundment dam shall be approximately 900 feet long and consists of four 16-foot high rubber dam sections anchored to a 3-foot high concrete sill. The upstream impoundment dam shall be approximately 975 feet long and consists of four 5-foot high rubber dam sections anchored to a 1-foot concrete sill. The design water surface in the lake is at Elevation 1148.0. The mechanical and control equipment for the rubber dams shall be located in the operations control buildings as indicated on the Drawings.

B. Description of Downstream Dam Operations:

1. During normal operation, the primary function of the downstream dam is to form the downstream limit of the lake and to control the water level in the lake. Control of the water level in the lake is important because of the OWNER's desire to have a continuous flow of water over the full length of the dam. Located just downstream of the lake in the north abutment of the dam shall be a pump station having a design capacity of 40 cubic feet per second (cfs), which correlates to approximately 1 inch of water flowing over the full 900-foot length of the impoundment dam. The pump station shall be part of a system designed to collect the water discharging over the dam and pump it back to the lake. Any waters discharging over the dam in excess of the pump station capacity will be lost from the lake and would have to be replaced at significant cost to the OWNER. The rubber dams shall be used to control the water level in the lake such that the flow over the dam can be maintained within the pump station capacity.
2. The secondary function of the downstream dam blowers during normal operation will be to assist in maintaining the water quality of the lake. An aeration/mixing system shall be installed to continuously discharge air from the dam inflation blowers to the base of the downstream dam where it will be diffused into the lake through a series of openings in the sill. The intent is that the air will assist in circulating and mixing the lake, thus reducing the stratification and resultant deoxygenation of the lake. Each of the four downstream dam operation blowers shall operate continuously to generate the air supply for the aeration/mixing system. When the control system indicates that air is required for maintaining the rubber dams, valves shall automatically open/close to divert the air into the dams.
3. During flood events the primary function of the downstream dam is to maintain a relatively stable water surface for the lake by deflating as

necessary to pass the flood without raising the resultant water surface to a greater elevation than specified by the Flood Control District of Maricopa County for floods of magnitudes of up to 290,000 cfs. Depending upon the magnitude of the flows, the dam shall either remain fully inflated or be partially deflated, as necessary, to allow flood flows to pass over the dam. Partial deflation of one or more of the rubber dams shall begin as flows approach 6,000 cfs, which corresponds to a 2-foot depth of water (lake elevation of 1,150 feet) going over the full length of the 16-foot high impoundment dam. The four rubber dams shall continue to partially deflate (rather than having one or more dams fully inflate) as necessary to maintain a lake elevation of 1,150 feet until flows reach 90,000 cfs, which corresponds to the 10-year storm. A flow of 90,000 cfs corresponds to an approximate 8-foot depth of water going over the full length of the partially deflated (to a height of 10 feet high) impoundment dam. At flows greater than 90,000 cfs, the rubber dams shall fully deflate. Upon recession of the flood hydrograph event, the dam shall reinflate to its original elevation. Reinflation shall occur at discharges of approximately 2,000 cfs.

C. Description of Upstream Dam Operations:

1. The primary function of the upstream dam during normal operation is to form the upstream containment of the lake and the downstream limit of the riparian area. No flow will normally be going over the rubber dam.
2. During flood events, the upstream dam may experience overtopping flows from either the downstream direction (if Indian Bend Wash is flowing) or the upstream direction (if the Salt River is flowing). During flood events, the upstream dam shall either be fully inflated or fully deflated. The upstream rubber dams shall not fully deflate except at flows greater than the 5-year flood event (30,000 cfs), which corresponds to a depth of 4 feet over the dam. The dam shall deflate in the downstream direction only. Upon recession of the flood hydrograph event, the dam shall reinflate to its original elevation. Reinflation shall occur at discharges of approximately 2,000 cfs.

1.2 WORK COVERED BY THESE DOCUMENTS

A. The Work in this Contract comprises the design, manufacture, delivery, and advisory services during installation of the upstream and downstream inflatable/deflatable rubber dam components complete with the rubber dam bodies, all embedded bolts, nuts, clamping plates, attachments fittings for air inflation/deflation, pressure sensor, and water drainage piping, an electrical control panel, auto-deflation operations panel, air blowers, and other associated mechanical equipment, rubber repair supplies and tools. Rubber dam supplier shall provide a technical advisor at Project location during appropriate stages of rubber dam installation, startup testing, and training of OWNER. The Work shall be as specified herein. All accessories required for satisfactory installation and operation of the equipment shall be furnished and installed whether or not explicitly mentioned in the Specifications or shown on Drawings. The aeration piping inside the control building shall be part of this Work. The aeration piping

from outside the control building to the dams and the aeration distribution equipment shall not be part of this Work.

1.3 SUBMITTALS

A. The following information, plus any additional information called for in the Specifications, shall be submitted prior to fabrication:

1. Complete manufacturer's specifications and drawings, including material description.
2. Description of manufacturer's standard prime and finish coating.
3. Recommended spare parts and cost information.
4. List of special tools furnished with the equipment.
5. List of materials and supplies furnished with the equipment.
6. Design calculations.
7. Samples of materials

B. Calculations shall be clear and in English and shall show all forces and stress internal to the rubber dam and imparted externally to the concrete foundations. The Drawings shall show and identify all equipment to be supplied. Descriptive literature shall be provided to allow purchase of replacement parts in the future. Preliminary drawings for rubber dam, control equipment, blower characteristics, etc., shall also be included in the Submittals.

C. ENGINEER's review will be general and not relieve the CONTRACTOR of the entire responsibility for the correctness of calculations and details, and from furnishing materials and performing Work required by the Contract, regardless of omissions on the Shop Drawings. The review of drawings shall in no way operate to waive or modify any requirements of these Specifications.

D. No Work shall be performed in connection with the fabrication or manufacture of materials and equipment, nor shall any accessory or appurtenance be purchased until the Shop Drawings and data therefor have been reviewed, except at the CONTRACTOR's own risk and responsibility.

E. Should the CONTRACTOR propose any item on its Shop Drawings, or incorporate an item into the Work, and that item should subsequently prove to be defective or otherwise unsatisfactory (regardless or the ENGINEER's review), the CONTRACTOR shall, at his own expense, replace the item with another item that will perform satisfactorily.

1.4 OPERATION AND MAINTENANCE (O&M) MANUALS

A. Furnish six copies of a complete instruction manual for installation, operation, maintenance, and lubrication requirements for each component of mechanical and electrical equipment. Each instruction manual furnished shall be fixed in hard-back cover or file folder which is clearly labeled to designate the equipment for which it is intended with reference to the building and equipment number, and the Specification section where the item is specified.

B. The manuals shall be furnished at least 15 calendar days prior to the scheduled delivery of equipment. Any deficiencies found by the ENGINEER to exist in the manuals submitted shall be corrected by the Supplier within 30 calendar days following notification by the ENGINEER of the deficiencies.

C. Each instruction manual shall included, but not be limited to, the following:

1. Diagrams and illustrations.
2. Detailed description of the function of each principal component of the system.
3. Performance and nameplate data.
4. Installation instructions.
5. Procedure for starting.
6. Proper adjustment
7. Test procedures.
8. Procedure for operating.
9. Shutdown instructions
10. Emergency operating instructions and troubleshooting guide.
11. Safety precautions.
12. Maintenance and overhaul instructions which shall include detailed assembly drawings with part numbers, part lists, instructions for ordering spare parts, and complete preventive maintenance instructions required to ensure satisfactory performance and longevity of the equipment.
13. Lubrication instructions, which shall list points to be greased or oiled, shall recommend type, grade, and temperature range of lubricants, and shall recommend frequency of lubrication.
14. List of electrical relay settings and control and alarm contact settings.
15. Electrical interconnection wiring diagram for equipment furnished, including all control and lighting systems.

D. The manual shall be complete in all respects for all equipment, controls, accessories, and associated appurtenances.

1.5 MANUFACTURER'S SERVICES DURING CONSTRUCTION

A. Competent and experienced technical representatives shall represent the manufacturers of all equipment and systems as may be necessary to resolve assembly or installation problems at the Work site which are attributable to, or associated with, the equipment furnished.

B. The manufacturer's representative shall certify in writing that the equipment (or system) has been installed in accordance with the manufacturer's recommendation and has been inspected by a manufacturer's authorized representative, that it has been serviced with the proper initial lubricants, that applicable safety equipment has been properly installed, and that the proper electrical and mechanical connections have been made.

C. The manufacturer's representative shall assist with the initial test, which shall include, but not be limited to, checking for proper rotation, alignment, speed, excessive vibration, and noisy operation. Initial equipment and system adjustment and calibrations shall be performed in the presence of,

and with the assistance of, the manufacturer's representative. The above-mentioned manufacturer's certification shall include the statement that proper adjustments have been made, and that the equipment or system is ready for plant startup and operation.

D. The manufacturer's representative shall furnish technical assistance for performance testing of the equipment or system furnished, or when assistance is necessary due to any malfunction of the equipment or system. The manufacturer's representative shall conduct and/or assist with final performance and demonstration testing. These services shall continue until such times as the applicable equipment or system has been successfully performance tested and has been accepted by the OWNER for full-time operation.

1.6 TRAINING OF OWNER'S PERSONNEL

A. The manufacturer's representative shall furnish detailed instructions to the OWNER's personnel for operation of the specified equipment. These training services shall include pre-startup classroom and onsite equipment instruction.

PART 2 PRODUCTS

2.1 GENERAL

A. For each component, provide end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.

2.2 SERVICE CONDITIONS

A. Hydrology:

1. The Salt River in the vicinity of the Project has a design discharge of 250,000 cfs. At this discharge, the approximate flow depth is estimated to be 22 feet at an average velocity of 11 to 12 feet per second.
2. During high rates of flow the river will transport bed sediment material with average diameter (d50) of about 9 inches. Larger sizes, up to several feet in diameter, may be transported in some instances. In addition flows shall contain significant debris, including, concrete and asphalt rubble, landfill material, trees, other plant material, etc.

2.3 PERFORMANCE CRITERIA

A. General:

1. Each rubber dam shall be inflatable with air and designed for installation on a concrete foundation within the river bed, as shown. The dam shall be designed such that when fully deflated the fabric does not present bulges or high points which may be subject to damage. The dam shall be attached to the concrete foundation with

either a single anchor line along the upstream edge of the rubber dam body or dual anchor lines.

2. The blower and piping system for each dam shall be sized to allow full inflation of the dam in 2.5 hours and deflation of the dams in 1 hour.
3. Each rubber dam shall be designed to provide a fully aerated nappe overflow condition for overflow depths of 6 feet at both the downstream and the upstream dams.

B. General System Operation:

1. Each rubber dam shall be operated at the normal internal pressure required to resist the design water level of 1,148.0 feet. Air shall be supplied to each dam by a high-capacity air blower. The blowers shall operate on 480-volt, three-phase power. Air shall be allowed to exhaust from the rubber dam either through a fail-safe mechanical float/butterfly valve system which senses upstream water elevations (not required for the upstream dam) or through a motorized butterfly valve (MOV) that can be controlled manually or automatically from the electrical control panel. When the mechanical exhaust system is activated, power to the air blower is interrupted so that each dam shall not re-inflate unless a manual intervention is performed.
2. Under normal circumstances, each dam shall be inflated to its design operating pressure. A pressure transducer in the control room shall continually monitor the internal pressure inside each rubber dam. If the pressure deviates from the design pressure, the electrical control panel shall automatically deflate or inflate the dam.
3. The control system shall be designed to provide the maximum protection against upstream flooding. In addition to the fail-safe mechanical auto-deflation system, an electrical auto-deflation system shall be provided. A water level transmitter installed in the stilling well shall send a level signal to the electrical control panel. If the water level reaches the auto-deflation depth, the control panel shall automatically open the MOV exhaust valve and lower the dam. This auto-deflation shall usually be set 2 inches below the mechanical deflation set point.

C. Downstream Dam Systems Operation:

1. The downstream dam shall be designed to operate in either a fully inflated position, a partially deflated position, or a fully deflated position for extended periods of overtopping (90 days) without experiencing damage to either the rubber fabric or anchoring system.
2. During periods of normal operation, pressure in each of the downstream rubber dams shall be automatically controlled such that the dam crest elevation will be maintained within an interval of plus or minus 1/2 inch of the target elevation chosen by the OWNER. The target elevation chosen by the OWNER shall be within the range of Elevation 1146.0 and Elevation 1148.0.
3. During flood events, the pressure in each of the downstream rubber dams shall be automatically controlled such that a maximum water surface of 1150.0 feet, plus or minus 3 inches (approximately 2 feet of overtopping), will be maintained. When the water level begins to

exceed 1,150 feet, the rubber dams shall automatically deflate as necessary to maintain a maximum water level of 1,150 feet, plus or minus 3 inches, until the dam is approximately 40 percent deflated, or 10 feet in height. At this point, if the water level continues to rise, the dams shall continue to deflate as necessary to maintain a maximum water surface of 1,150 feet, plus or minus 1 foot. The dams shall be capable of deflating either simultaneously, or in any sequence chosen by the OWNER. When the water level begins to recede and reaches an elevation of 1,134 feet, the dams shall automatically fully inflate. The pressure of the fully inflated dams shall be such that the dam crest will be at the required target elevation.

D. Upstream Dam:

1. The upstream dam shall be designed to operate in either a fully inflated or fully deflated position for extended periods of overtopping, (90 days) without experiencing without experiencing damage to either the rubber fabric or anchoring system.
2. During periods of normal operation, the pressure in each of the upstream rubber dams shall be automatically controlled such that the dam crest elevation will be maintained within an interval of plus or minus 1 inch of the target elevation chosen.
3. During flood events, the pressure in each of the upstream rubber dam sections shall be automatically controlled such that when the water level begins to exceed 1,152 feet (approximately 4 feet of overtopping) the two inner rubber dams shall automatically fully deflate. If the water level continues to rise above 1,152 feet, the two outer rubber dams shall fully deflate. Full reinflation of the rubber dams shall be by manual operation of the OWNER.

E. Piping: The piping system shall be designed to limit the potential for blockages forming in the air inflation/deflation lines. The system shall provide independent drains for removing condensate and leakage from the interior of the rubber dam body. The system shall be designed to require the minimum number of penetrations of the rubber fabric. The air piping shall be either Schedule 40 carbon steel or galvanized steel in accordance with ASTM A120 with flanged or welded joints. The pressure sensing and water drainage piping shall be either stainless steel flanges or Schedule 40 PVC with socket welded joints.

F. Anchoring:

1. The anchoring system shall be designed for maximum reliability, air tightness, and ease of installation. The clamping design shall permit convenient unclamping and reclamping the dam without damaging the dam fabric.
2. The dam shall be designed to be anchored to the concrete foundation slab as shown. The allowable shear and tension of anchor bolts used for attachment to the concrete shall not exceed that specified in Table 19E of the 1994 Uniform Building Code (UBC), considering a design concrete compressive stress of 4,000 pounds per square inch.

G. Minimum factors of safety shall be:

1. Rubber Dam Body: The rubber dam body shall be designed with a minimum factor of safety of 8 based on the design tension for the normal operating conditions.
2. Anchor Bolts: The anchor bolts shall be designed with a minimum factor of safety of 3 based on the anchor bolt ultimate tensile stress.

H. Physical Dimensions: Dimensions of each rubber dam shall be as indicated on the Drawings.

2.4 RUBBER DAM MATERIALS

A. Materials shall be new, free from defects and imperfections, and shall have certified test reports of the properties listed in this section declaring the materials furnished conform to the following:

1. Rubber Dam Body: The rubber dam body shall be sandwich type construction comprised of layers of nylon-reinforced rubber with armor protection beneath the outer cover. Ozone and ultra-violet protection shall be made integral with the rubber fabric. The rubber dam body shall be designed to control/reduce oscillation during periods of overtopping. Minimum nominal fabric thickness for the downstream rubber dam shall be 0.50 inch. Minimum nominal fabric thickness for the upstream dam shall be 0.31 inch.
2. Armor Protection (Downstream dam only): The rubber dam fabric shall have armor protection that will resist slashing or piercing by knives (vandalism) or other sharp objects. This protection shall consist of ceramic chips, stainless steel wire mesh, or other suitable materials that are permanently embedded into the fabric. The material shall be uniformly distributed under the downstream portion of the exposed outer cover that extends from a height of 2 feet above the concrete sill to a height of 6 feet above the concrete sill. The armor protection shall not be visually perceptible or alter the outward appearance of the outer cover. The supplier shall submit fabric samples and the results of fatigue and bend tests which confirm the performance and durability of the armor protected fabric.

B. The fabricated dam body shall be tested to conform to the following:

1. Tensile breaking strength for the downstream dam shall be a minimum of 7,800 pounds per linear inch in the circumferential direction and a minimum of 5,500 pounds per linear inch in the longitudinal direction when tested in accordance with ASTM D751, Grab Method.
2. Tensile breaking strength for the upstream dam shall be a minimum of 1,400 pounds per linear inch in the circumferential direction and a minimum of 1,200 pounds per linear inch in the longitudinal direction when tested in accordance with ASTM D751, Grab Method.
3. Elongation at breaking shall not be more than 30 percent when tested in accordance with ASTM D751, Grab Method.
4. The adhesion between the nylon canvas and the rubber shall be tested in accordance with ASTM D751. The adhesion shall be a minimum of 34 pounds per inch before aging in 158 degrees F for 96 hours,

and a minimum of 22 pounds per inch after aging in 158 degrees F for 96 hours.

5. The ozone test shall show no abnormality in appearance when subjected to an ozone test conducted at 110mPa, 104 degrees F, 96 hours, and 50 percent elongation, in accordance with ASTM D1149.
6. The abrasion test shall show less than 0.03 cubic inch of abrasion when subjected to the Taber abrasion test using an H18 stone with a 2.2 pound load for 1,000 repetitions as modified from ASTM C501.
7. The armor protection shall limit penetration of a knife blade, cutting at a 45-degree angle to the fabric, to less than 0.2 inch after 10 cycles at a cutting force of 35 pounds.

C. Miscellaneous Embedded Materials: The embedded materials shall conform to ASTM A167, AISI Type 316 Stainless Steel.

D. Clamping Materials: The clamping materials (plates, bars) shall conform to ASTM A536, Grade 80 for spheroid graphite cast iron or ASTM A36 for forged steel and shall be hot-dipped galvanized in accordance with ASTM A123.

E. Anchor Bolts: The anchor bolts, stainless steel washers, and nuts shall conform to ASTM A194, AISI Type 316 stainless steel.

F. Air Supply Devices: Each rubber dam shall be supplied with a dedicated blower. This equipment shall be supplied by the dam supplier. The blowers, valves, and piping appurtenances shall be configured to fit in a 23.3-foot by 12-foot room to provide ready access to equipment for service and repair.

G. Valving: Valves for the air inflation system at the upstream and downstream dams and for the aeration system at the downstream dam shall be supplied by the dam supplier.

H. Control System: The control system shall be designed and supplied by the dam supplier. The system shall consist of a control panel, instruments, and control devices, sufficient to implement the functional requirements as listed herein and as shown on the Drawings.

2.5 CONTROL SYSTEM

A. General:

1. Provide for each of two rubber dams a control system capable of monitoring and maintaining internal dam pressure as described in the functional descriptions and in the performance criteria.
2. Control of mechanical devices shall be through a programmable logic controller (PLC).
3. Primary operator interface shall be through a set of graphic screens programmed into a panel mount computer. Graphic screens shall display all measured system parameters and alarms, and shall allow operator selection of manual or automatic control of mechanical devices.

4. Manual backup controls shall be provided on the local control panel.
5. The control system computer shall provide for historical trending of system parameters.
6. System status and alarms shall be made available for transmission to a remote site via owner furnished telemetry equipment.
7. Provide an uninterruptible power supply (UPS), to supply power to system components and the OWNER-furnished telemetry equipment.
8. The downstream dam shall incorporate additional controls for a lake aeration system and recycle pump system.

B. Rubber Dam Control Panel (RDCP):

1. NEMA 12, freestanding, single-door, with three-point latching handle.
2. Filtered louvers with ventilation fans as necessary for operation in 100 degrees F ambient.
3. Panel shall be a standard manufactured item, Hoffman, H.F. Cox, or equal.

C. Operator Controls and Indications:

1. Power ON light.
2. OPEN/CLOSE pushbutton and OPEN and CLOSED indicating light for each of four vent valves.
3. START/STOP pushbuttons and ON indicating light for each of four blowers.
4. Panel-mounted computer/operator interface.
5. UPS TROUBLE indicating light.
6. SYSTEM TROUBLE indicating light.
7. For the downstream dam only, OPEN/CLOSE pushbutton and OPEN and CLOSED indicating light for each of four dam inflation valves, aeration valves, and three cross-connect valves.

D. External Interfaces:

1. For Both Dams:
   a. Receive 4 to 20 mA analog PRESSURE inputs from each of four rubber dam sections.
   b. Receive 4 to 20 mA analog LAKE LEVEL input.
   c. Receive contact closure OPEN and CLOSED position inputs from each of four vent valves.
   d. Receive contact closure ON inputs from each of four blower starters in the motor control center (MCC).
   e. Provide 4 to 20 mA analog LAKE LEVEL output to the telemetry panel.
   f. Provide contact closure RUN outputs to each of four blower motor starters in the motor control center.
   g. Provide contact closure OPEN and CLOSE outputs to each of four vent valves.
   h. Provide contact closure outputs to the telemetry panel for each of the following conditions: SYSTEM TROUBLE, DAM NOT FULLY INFLATED, and Auto-deflation INITIATED. SYSTEM TROUBLE alarm shall indicate any computer or PLC failure,

any mechanical device called but not operating, or any system parameter out of normal operating range.

2. For the Downstream Dam Only:
   a. Receive an additional 4 to 20 mA analog LAKE LEVEL signal from the auto-deflation stilling well.
   b. Receive a 4 to 20 mA analog RECYCLE FLOW signal from the recycle pump station.
   c. Receive contact closure OPEN and CLOSED position inputs from each of four dam inflation valves, four aeration valves, and three cross connect valves.
   d. Provide contact closure OPEN and CLOSE position outputs to each of four dam inflation valves, four aeration valves, and three cross-connect valves.
   e. Receive contact closure CLOSED position input from the auto-deflation panel.

E. Functional Requirements:

1. In MANUAL mode, the blowers and valves shall respond to the manual selector switches on the RDCP or the computer operator interface.
2. For the downstream dam, in AUTO mode, select one of four operating scenarios, as follows:
   a. MAX STORAGE/FLOOD CONTROL - Automatically control blowers and valves as necessary to maintain fully inflated dam sections and to control the maximum water surface during flood events. Lake levels shall be controlled as described under PERFORMANCE CRITERIA herein.
   b. CONTROLLED OVERFLOW ONLY - Run one blower continuously, cross-connected to all dam sections. Operate vent and inflation valves as necessary to control internal dam pressure such that the recycle flow is controlled to the operator input set point and that flow over the dam is evenly distributed across the full dam length. This control shall be maintained for lake levels within the range of Elevation 1147.0 and Elevation 1148.0 . If water level exceeds this range, operation shall revert to MAX STORAGE/FLOOD CONTROL. Lake aeration valves shall be closed. Automatically rotate the operating blower daily to equalize run times.
   c. LAKE AERATION ONLY - Run all available blowers continuously. Open lake aeration valves to admit air to the aeration diffuser. Operate vent and inflation valves as necessary to maintain fully inflated dam sections and to limit the maximum water surface during flood conditions.
   d. AERATION AND CONTROLLED OVERFLOW - Run all available blowers continuously. Open lake aeration valves. Operate vent and inflation valves as described in CONTROLLED OVERFLOW ONLY.
3. For the upstream dam, in AUTO mode, the dam shall operate as described in MAX STORAGE/FLOOD CONTROL above.
4. The control system shall monitor and display system parameters, control the process, and annunciate alarms to the graphic displays on the computer screens. Fully utilize the capabilities of the operator

interface software to provide the operator with clear, comprehensive graphic displays that accurately represent the process.

5. The control system shall log all alarms and system status and shall maintain historical data on all system parameters.
6. The system shall provide for downloading historical data for analysis or printing.

F. Power Requirements:

1. The RDCP shall be provided with 120-volt, single-phase power from the MCC. Supply all control components and motor-operated valves from the RDCP. Provide all transformers, power supplies, or rectifiers needed for control components.
2. Provide a UPS rated to supply power to all PLC and computer components, and having 1,000 VA extra capacity for the telemetry equipment. Run time on batteries shall be 2 hours, minimum.

G. Special Requirements: Provide additional hardware and software necessary to program and troubleshoot the control system.

H. Component Specifications:

1. General Construction: Design and construction shall be of the highest quality using good engineering practice and reliable components. All wiring shall be neatly tied and color coded. Terminal strips for control wiring, telemetry interconnection and incoming power shall be suitably located and properly labeled/identified.
2. Programmable Controller: The programmable controller shall consist of a Siemens/TI PLC processor Model 545 or approved equal along with a Siemens/TI digital/analogue input/output device, Sicomp PC-32-F, or approved equal.
3. Digital Panel Meter with BCD Output: Digital panel meter shall have 3-1/2 digits 0.00 to 8.00 psi display and a parallel BCD output. Input shall be 4 to 20 mA. Meter shall be Newport Q2404P, D1 or approved equal, and shall be on the telemetry input enclosures.
4. Digital Readout: Digital readout shall input 4 to 20 mA and provide 3-1/2 digit readout. Digital readout shall be Newport Q2404E or approved equal. It shall be on telemetry output panels.
5. Meters: Voltmeters, ammeters, and other meters shall be General Electric, Westinghouse, Simpson, or approved equal.
6. Alarm Annunciator: The alarm annunciator shall be Rochester Instrument Systems 12 point AN-3196B, or approved equal, programmed to standard "A" sequence (silence, acknowledge, reset). The annunciator shall be equipped with two programmable reflash outputs for remote monitoring of two groups of alarms.
7. Water Level Sensor: The water level sensor shall be small bore depth sensor and transmitters which shall display pond water levels on a digital readout in the control room. Alarms for high water and low water levels shall be actuated as shown on the Drawings. The sensor shall be equal to Druck PTX 161/D or PTX 165 of Druck Inc.; 4 Dunham Drive; New Fairfield, Connecticut 06812, or approved equal.

a. Ranges as Follows: LT-2-7 and LT-1-4, 0 to 10 psi, LT-2-6, 0 to 1 psi.

8. Pressure Switch: Sensitive pressure switches for air pressure system shall be adjustable and in a weatherproof enclosure with dual double-throw switch rated 10 amperes, 125 volts. Unit shall withstand test pressure of 10 psi. Unit shall be Barksdale D2T-A3 with 40801 surge damper or approved equal.
9. Pressure Transducers: The pressure transducers shall cover the range from 0 to 5 psi gauge air pressure. Electrical output shall be 4 to 20 ma for 0 to 5 psi, the transducer output shall vary directly with applied pressure. Transducer shall be designed for telemetering applications with 1 percent of full scale accuracy and sealed ruggedized construction. Pressure transducer shall be Druck, Model PTX-520 or approved equal. A test and isolation valve shall be installed in the system.
10. Pushbuttons: Pushbuttons shall have contacts as required or shown on Drawings. Provide color insert as shown on Drawings. Pushbuttons shall be Square D Class 9001 Type K or approved equal.
11. Indicating Lights: Lights shall be push-to-test type and have two-pole double-throw switch for testing light. Indicator lights shall be Square D Class 9001 Type K or approved equal.
12. Terminal Block: Terminal block shall have an insulated barrier between screw terminals.
13. Control Relays for Motor Starters: The relay controlling motor starters shall be machine-tool type with contacts rated 10 amperes at 600 volts open type, Machine-tools relays shall be Square D, Class 8501, DPDT Type KP-12, Form P0140120V, 50-60Hz with relay socket Square D, Class 8501, Type NR-51 or approved equal.
14. Control Relays for General Use: Control relays or general use (not controlling starters) shall be plug-in type, Square D, Class 8501, DPDT Type KP-12, Form P-16-120V, 50-60Hz with relay socket Square D, Class 8501, Type NR-51 or approved equal.

PART 3 EXECUTION

3.1 MANUFACTURING AND INSTALLATION

A. The rubber dam supplier shall supply material of high and consistent quality.

B. Material Testing: Materials testing shall be recorded, and test certificates submitted to the OWNER.

C. Tolerance: The thickness of the rubber dam shall be uniform plus or minus 15 percent. Jointed sections of the rubber dam shall be of the same thickness as the parent fabric.

D. Manufacturing: The rubber fabric shall be fully vulcanized using a high-pressure heat vulcanization method.

E. All construction and installation shall be in full compliance with all applicable codes and regulations.

F. Shipping: The Installation Contractor shall arrange for the delivery of the dam and control equipment to the construction site.

G. Initial (Functional) Testing: The equipment shall be tested, which shall include checking for proper rotation, alignment, speed, excessive vibration, and noisy operation.

H. Final (Performance) Testing: The installed rubber dams and piping systems shall be leak tested before final acceptance. All systems shall be tested under the direction of the manufacturer's representative to demonstrate that all equipment furnished and installed and connected under the provisions of these Specifications function satisfactorily in the manner required. The rubber dams and piping systems shall have no water or air leakage. Testing shall be performed in accordance with procedures approved by the OWNER and in the presence of the OWNER and ENGINEER. All tests shall be documented. Tests shall be done in dry and wet conditions and shall include all components of rubber dam and control and deflation/inflation equipment.

1. Dry Performance Test: A performance test of each rubber dam shall be conducted prior to the lake being filled with water to ensure that each rubber dam shall completely deflate and inflate in accordance with the Specifications. However, because of the absence of water, adherence to the specified deflation time will not be required during the dry performance test. The test shall consist of at least two cycles of full inflation followed by full deflation. Full inflation is reached when the pressure in the dam is that required to retain at least 16 feet and 5 feet of water for the downstream and upstream dams, respectively. Full deflation is reached when the pressure in the dam is at zero, plus or minus 0.1 psi. At no time during the test will any leakage of air be detectable by visual or audible means. Each rubber dam shall remain at full inflation for a minimum of 1 hour, during which the pressure shall not decrease by more than 1.0 psi. Blowers and equipment shall operate without excessive vibration.
2. Wet Performance Test:
   a. A performance test of each rubber dam shall be conducted in the wet to ensure that each rubber dam operates in accordance with the performance requirements of this specification. The wet performance test shall not be conducted until the rubber dam successfully passes the dry performance test. The wet performance test shall be conducted after the lake has been filled with water to Design Elevation 1148.0.
   b. OWNER will pay for and provide the necessary water for the initial wet performance test. If each dam does not successfully pass the wet performance test and requires additional testing, payment for the additional water required for subsequent testing will be the responsibility of the manufacturer.
   c. Testing of the downstream dam shall be to ensure that the dam will operate as specified under both normal conditions and during flood events. Testing of each downstream rubber dam shall be for the following specific performance requirements:
      1) Lower the dam elevation from 1,148.0 feet to 1,147.8 feet and control the rubber dam elevation to within 1/2 inch of

Elevation 1147.8 (using pressure as an indicator) for a duration of 1 hour.

2) Partially deflate and inflate each rubber dam. Each rubber dam shall be deflated to a crest elevation of 1,145.0 feet and this elevation shall be maintained for a duration of 1 hour. There shall be no evidence of any damage to the rubber dam fabric and/or anchoring system.

d. Testing of each upstream rubber dam shall be to ensure that the dam will operate as specified under both normal conditions and during flood events. Testing of each upstream rubber dam shall be for the following specific performance requirements:

1) Fully deflate and inflate within the specified duration times without damage to the rubber dam and anchoring system. This test shall only be conducted with flow going in the downstream (east to west) direction. There shall be no evidence of any damage to the rubber dam fabric and/or anchoring system.

3.2 WARRANTY

A. The Supplier shall obtain a Certificate of Warranty from the manufacturer and deliver the ertificate to the OWNER. The Certificate of Warranty shall be made out in favor of the OWNER and shall contain all the provisions enumerated in the following paragraphs:

1. The manufacturer warrants the fabric portion of each rubber dam installed from defects in material and workmanship excluding normal wear and deterioration for a period of 10 years from the date of acceptance of the completed installation of each dam, assuming the performance of reasonable periodic maintenance by the OWNER in accordance with the recommendation of the manufacturer.
2. In the event of a defect becoming apparent, the manufacturer shall be immediately notified through the Supplier that the fabric does not conform to the criteria specified in these Specifications. The manufacturer shall have the right to repair the fabric, or the portion thereof which has been determined to have been OWNER, without cost to the OWNER.
3. Manufacturer's warranty of replacement of defective fabric as outlined above is based on the current price of like materials at the time of replacement and will not be pro-rated.

B. The warranty for workmanship involving assembly of each rubber dam shall be for a period of 5 years and expire the fifth year after acceptance of Contract. Workmanship will not be pro-rated.

C. Equipment: A 2-year written guarantee from the date of acceptance of the Project shall be provided by the CONTRACTOR to guarantee that the blower, operation and control equipment, and all accessories shall perform as stated in these Specifications. There shall be no defects in material or workmanship in any items supplied. The CONTRACTOR shall replace, at

no cost to the OWNER, any item furnished which fails to perform as specified.

END OF SECTION

SECTION 13005
INSTALLATION OF OWNER-FURNISHED PRODUCTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work necessary to inspect and unload, store and protect, assemble and install, conduct and coordinate testing, schedule manufacturer's services, complete and ready for use, the OWNER-furnished product(s).

B. Specifications for the OWNER-furnished product(s) are included in these Contract Documents under Section 11851, RUBBER DAMS, for information only.

1.2 DEFINITIONS

A. Manufacturer: Where "manufacturer" is referred to in this section, it refers to the party under separate Contract with the OWNER for furnishing the material or equipment products purchased by the OWNER. Such party may be referred to as "Contractor for OWNER-furnished Products" or "OWNER-furnished Equipment Contractor" in other sections.

B. Transfer: "Transfer" of OWNER-furnished products to the CONTRACTOR refers to the time when manufacturer's instructions for unloading, handling, storage, and protection have been received; products have been delivered to the jobsite and jointly inspected; any damage or loss has been reported in writing to RESIDENT ENGINEER; and OWNER has accepted such products as ready for unloading, storage, and protection by the CONTRACTOR.

1.3 PRODUCTS FURNISHED BY OWNER

A. The following products will be provided by the OWNER and installed by the CONTRACTOR. Installation of OWNER-furnished products shall be as specified herein and as specified in the applicable detailed product specification.

Specification Reference No.	Specification Paragraph	Product Description
11851	1.2	Upstream and downstream inflatable/deflatable rubber dam components complete with the rubber dam bodies, all embedded bolts, nuts, clamping plates, attachments fittings for: air inflation/deflation, pressure sensor, and water drainage and piping; an electrical control panel, control systems, auto-deflation operations panel, air blowers and other associated mechanical equipment, rubber repair supplies and tools.

1.4 CONTRACTOR'S RESPONSIBILITY FOR COMPLETE SYSTEM

A. CONTRACTOR shall have complete responsibility for necessary storing, handling, installing, adjusting, maintaining, lubricating, testing, and operational startup of OWNER-furnished products. Provide and coordinate the construction of interconnecting structures, equipment, piping, electrical and instrumentation work, and appurtenances to achieve installation and operation of the OWNER-furnished products as shown and specified and as required to provide a complete and functional system.

B. See Article INSURANCE for CONTRACTOR's insurance requirements.

1.5 MANUFACTURER'S RESPONSIBILITY FOR PRODUCTS

A. The manufacturer will be responsible for providing the following:

1. Factory testing and certification of test results.
2. Notification 10 calendar days prior to shipment, and 48 hours prior to delivery.
3. Certification of proper installation.
4. Training of OWNER's personnel.

B. OWNER's Contract for purchase of products include manufacturer's services.

1.6 EQUIPMENT DELIVERY SCHEDULE

A. Product delivery schedule information for all OWNER-furnished products will be made available to the CONTRACTOR as soon as these dates have been established. Such information will include approximate shipping weights of separate components, method of shipment, destination point, date of shipment, approximate date of delivery, and methods for handling, storage, and protection.

1.7 INFORMATION FURNISHED BY OWNER

A. Shop drawings of the OWNER-furnished products will be made available for CONTRACTOR's use in performing the work under this section.

Revisions to these shop drawings will be furnished if they affect the installation work.

B. Manufacturer's installation, operation, and maintenance instructions for the OWNER-furnished products will be made available for CONTRACTOR's use.

1.8 APPLICABLE STANDARDS

A. Comply with applicable portions of the 1994 editions of the Uniform Building Code, the Uniform Mechanical, the Uniform Plumbing Code, the 1994 Uniform Fire Code, the 1993 National Electrical Code, all and any state and city amendments, and other codes referenced in the Specifications for the OWNER-furnished products. If a discrepancy or conflict should exist between governing codes, the most stringent requirements shall have precedence.

1.9 SUBMITTALS

A. Furnish, as a part of the work under this section, detailed shop drawings to indicate the layout, location, and identification of materials provided by CONTRACTOR.

1. Include pipe, fittings, valves, specialties, hangers, supports, equipment, and required specialties.

B. Submit complete list of materials to be furnished, and include data necessary to allow DESIGN ENGINEER to determine their fitness for the work.

C. Submit plans to repair or replace products that becomes damaged or lost after transferred to CONTRACTOR for storage and protection.

D. Submit functional test logs and performance test reports as required for specific equipment tested.

1.10 SEQUENCING AND SCHEDULING

A. CONTRACTOR shall verify availability of OWNER-furnished products by contacting the OWNER before making final arrangements for, or committing resources to, the unloading, handling, storage, protection, or installation of such products. No additional time or compensation will be considered unless CONTRACTOR has made every effort to monitor delivery schedules of OWNER-furnished products.

1.11 INSURANCE

A. The CONTRACTOR shall include in the insurance for work under this Contract, sufficient coverage to protect the OWNER-furnished products against all losses during unloading, storage, handling, protection, and installation and until final acceptance of the work by the OWNER. The

OWNER, RESIDENT ENGINEER, and DESIGN ENGINEER shall be named as additional insured(s) for this Work.

B. For purposes of this insurance coverage, the estimated value of the OWNER-furnished products, submitted per Section 11851, RUBBER DAMS, will be verified prior to Award of the Contract.

Product Description	Qty.	Unit	Unit Price	Extended Price
Downstream Rubber Dam Fabric w/Armoring	4	EA	$603,592	$2,414,370
Embedded Items	4	EA	$143,265	$ 573,060
Control Room Mechanical Equipment	1	LS	$431,000	$ 431,000
Electrical/I&C Equipment	1	LS	$100,000	$ 100,000
Subtotal Downstream Dam				$3,518,430
Upstream Rubber Dam Fabric	4	EA	$ 90,480	$ 361,920
Embedded Items	4	EA	$ 22,620	$ 90,480
Control Room Mechanical Equipment			$ 41,400	$ 41,400
Electrical/I&C Equipment			$ 35,000	$ 35,000
Subtotal Upstream Dam				$ 528,800
TOTAL				$4,047,230

PART 2 PRODUCTS

2.1 GENERAL

A. Provide products required to complete the work under this section, except where specifically specified as "OWNER-furnished". Such products include, but are not limited to, earthwork, concrete slabs and piers, abutments, stilling well, equipment pads, inserts, anchor bolts, connecting piping and valves, hangers and supports, motor starters and wiring, piping accessories, specialties, finish painting, and expendable materials, all as necessary to provide a complete and properly functioning system.

2.2 MISCELLANEOUS PRODUCTS

A. General: Furnish incidental products, such as gaskets, supports, bolts, and lubricants, as shown and as required for proper operation of equipment installed under this section unless specifically noted as supplied by manufacturer (see Section 11581, RUBBER DAMS). Products shall

conform to applicable sections of these Specifications for the intended service.

B. Equipment Foundation Pads: Provide foundation pads for OWNER-furnished equipment, as required by the equipment manufacturer and as specified in Section 03300, CAST-IN-PLACE CONCRETE. Approximate pad sizes are shown on the Drawings. CONTRACTOR shall verify exact dimensions and configuration of all pads, including penetrations, with the manufacturer's shop drawings.

C. Anchor Bolts: Furnish anchor bolts, fasteners, washers, etc., and templates needed for installation of OWNER-furnished air blowers. Anchor bolts, fasteners, etc., needed for the installation of the rubber dam segments will be furnished by the dam manufacturer. Furnish materials and shoring for rubber dam anchorage assembly as required by the dam manufacturer.

1. Verify the number and size of anchor bolts furnished by the manufacturer and furnish all necessary anchor bolts not furnished with the equipment.
2. Size and locate anchor bolts in accordance with manufacturer's shop drawings and installation instructions.
3. Anchor bolts, fasteners, washers, etc., shall be Type 316 stainless steel.

PART 3 EXECUTION

3.1 GENERAL

A. Installation work shall conform with manufacturer's recommended procedures, instructions, and shop drawings, as accepted by the RESIDENT ENGINEER.

B. Receive, unload, transport to its place of installation, inspect, sort, handle, and protect OWNER-furnished products as specified in Section 01600, MATERIAL AND EQUIPMENT.

C. Maintain complete inventory on all OWNER-furnished products after their transfer to CONTRACTOR.

D. Install piping, valves, and miscellaneous fittings in accordance with manufacturer's instructions and with Section 15060, PIPING–GENERAL, and appropriate Detail Piping Specifications, and with Section 15100, VALVES AND OPERATORS.

E. Install and connect electrical equipment in accordance with Division 16, ELECTRICAL, and with equipment manufacturer's instructions.

3.2 INSPECTION PRIOR TO UNLOADING

A. Prior to transfer of OWNER-furnished products to the CONTRACTOR, the CONTRACTOR and OWNER's representative shall jointly inspect the condition of each product.

1. CONTRACTOR shall record in writing he products transferred to the CONTRACTOR's care.
2. Damage to or loss of equipment and materials shall be immediately reported to the OWNER.
3. Unload the OWNER-furnished products, after any damage or loss is reported, as specified in Section 01600, MATERIAL AND EQUIPMENT, unless otherwise directed by the OWNER.
4. Do not unload products to be returned to manufacturer for repair or replacement, unless necessary to expedite return shipping.

3.3 STORAGE AND PROTECTION

A. Following transfer of OWNER-furnished products, and until final acceptance of the completed work, CONTRACTOR shall protect and maintain products to prevent damage in accordance with manufacturer's instructions, and as specified in Section 01600, MATERIAL AND EQUIPMENT.

B. Equipment susceptible to damage by the elements shall be placed in an acceptable temporary storage building prior to installation. Replace products that become corroded, damaged, or deteriorated with new products prior to installation and acceptance of the work.

C. Damage to or loss of products after the date of their transfer to CONTRACTOR shall be repaired to original condition, or replaced with new identical products, as reviewed and accepted by RESIDENT ENGINEER.

D. Damage to or loss of products unloaded to expedite return shipment for repair or replacement shall be repaired to original condition, o replaced with new identical products, as reviewed and accepted by RESIDENT ENGINEER.

3.4 PREINSTALLATION MEETING

A. CONTRACTOR shall arrange and attend a preinstallation meeting with the manufacturer(s) to review general procedures, erection and installation instructions, and installation sequence.

1. Provide 10 days' advance notice of the proposed date for starting installation.
2. Additional meetings prior to installation may be required, as determined by the OWNER, to transmit manufacturer's installation instructions to the CONTRACTOR.
3. RESIDENT ENGINEER and OWNER's representative may attend the meetings.

3.5 INSTALLATION

A. Provide supervision, labor, tools, construction equipment, incidental materials, and necessary services required to install and test the OWNER-furnished products.

B. Excavation, concrete, mechanical, and electrical work shall conform to applicable standards, final stamped and reviewed shop drawings, Specifications, and Drawings included in these Contract Documents, including manufacturer's installation instructions.

C. Pumps, valves, and electrical equipment shall be properly aligned, plumb and level, with no stresses on connecting piping or conduit.

D. Verify operability and safety of electrical system needed to operate the equipment. Check electrical system for continuity, phasing, grounding, and proper functions.

3.6 PAINTING

A. Painting shall be in accordance with Section 09900, PAINTING. Stainless steel surfaces shall not be painted.

B. OWNER-furnished products will be delivered with prime coats only and shall be finish painted by the CONTRACTOR.

1. Protect equipment to minimize damage to the prime coat.
2. Repair damage to primed surfaces to the satisfaction of the OWNER, including surface preparation, and apply a mist prime coat to entire surface prior to applying finish coats.
3. Paint applied by CONTRACTOR shall be fully compatible with primers applied by manufacturer. See detailed product specification sections and Section 09900, PAINTING.

3.7 MAINTENANCE

A. Immediately after installation, lubricate components in accordance with manufacturer's instructions.

B. Follow manufacturer's instructions for maintenance during storage, after installation but prior to testing and startup, and after startup but prior to OWNER's acceptance.

C. Notify RESIDENT ENGINEER immediately in event that manufacturer's spare parts and maintenance materials are not available.

D. Furnish incidental maintenance, labor, and supplies including lubricants, cleaning fluids, nuts and bolts, and similar products not furnished by manufacturer, as needed for maintaining the OWNER-furnished products.

3.8 FIELD TESTING

A. GENERAL

1. Perform field testing as specified in the appropriate specification section and as specified below.
2. Give full access to work by and cooperate with manufacturer(s) during testing to enable gathering of data and information necessary to

evaluate performance and develop recommendations for acceptable operation and maintenance instructions.

3. Unless otherwise specified below for specific equipment tests, prepare all test logs and reports for submission.

B. Preparation: Prepare OWNER-furnished equipment for startup including cleanup, lubrication, motor phasing, motor test running, and equipment tolerance adjusting. Furnish incidental materials required for this preparation.

1. Check and adjust settings of components prior to startup.
2. Verify that equipment has been serviced with proper lubricants and that applicable safety equipment has been installed.
3. Verify that proper mechanical and electrical connections have been made.
4. Correct misalignment, vibration, excessive noise, or other evidence of improper setting obtained from short startup tests. Do not use flexible couplings to compensate for misalignment.
5. Clean strainers on control valves and verify pressure settings.
6. Correct defects in installation s required by manufacturer's instructions and recommendations.
7. Manufacturer's certification of proper installation for each equipment system must be received by OWNER prior to starting functional testing.

C. Functional Tests:

1. Following startup preparation, conduct a functional (or run) test on each OWNER-furnished equipment unit in the presence of the OWNER and manufacturer's representative as specified in Section 01650, FACILITY STARTUP.
2. Submit report or test log of satisfactory functional test for each type of equipment.
   a. OWNER will transmit a copy of the log to manufacturer for review.
   b. Manufacturer's approval to conduct performance testing must be received by RESIDENT ENGINEER prior to starting performance testing.
3. Make adjustments to installed equipment as recommended by manufacturer prior to proceeding to performance testing.

D. Performance Tests:

1. Prior to facility startup, equipment shall be performance tested as specified in the applicable equipment specifications in Section 01650, FACILITY STARTUP, and as specified below. Such testing shall be performed by the CONTRACTOR.
2. Prior to the rubber dam performance tests, manufacturer's representative will install the necessary software into the electrical panel.
3. Schedule tests in cooperation with the OWNER and the manufacturer's representative.

4. Performance testing shall continue for a continuous 1-hour period without malfunction or sign of apparent weakness in the equipment. In event the equipment fails the initial test, replace or repair equipment and repeat the testing procedure until performance requirements are met.
5. Final (Performance) Testing: CONTRACTOR shall be responsible for testing of the installed rubber dams and piping systems before final acceptance. All systems shall be tested under the direction of the manufacturer's representative to demonstrate that all equipment furnished and installed and connected under the provisions of Article 2.3 of Section 11851, RUBBER DAMS, function satisfactorily in the manner required. The rubber dams and piping systems shall have no water or air leakage. Testing shall be performed in accordance with procedures approved by the OWNER and in the presence of the OWNER and RESIDENT ENGINEER. All tests shall be documented. Tests shall be done in dry and wet conditions and shall include all components of rubber dam and control and deflation/inflation equipment.
   a. Dry Performance Test: A performance test of each section of the downstream and upstream rubber dams shall be conducted prior to the lake being filled with water to ensure that each rubber dam shall completely deflate and inflate in accordance with Article 2.3 of Section 11851, RUBBER DAMS. The test shall consist of at least two cycles of full inflation followed by full deflation. Full inflation is reached when the pressure in the dam is that required to retain at least 16 feet and 5 feet of water for the downstream and upstream dams, respectively. Full deflation is reached when the pressure in the dam is at zero, plus or minus 0.1 psi. At no time during the test will any leakage of air be detectable by visual or audible means. Each rubber dam shall remain at full inflation for a minimum of 1 hour, during which the pressure shall not decrease by more than 1.0 psi. Blowers and equipment shall operate without excessive vibration.
   b. Wet Performance Test:
      1) A performance test of each downstream rubber dam section shall be conducted in the wet to ensure that each section operates in accordance with the performance requirements of Article 2.3 of Section 11851, RUBBER DAMS. The wet performance test shall not be conducted until the rubber dam successfully passes the dry performance test. The wet performance test shall be conducted after the lake has been filled with water to Design Elevation 1148.0. Filling of the lake may not be completed until several months after the installation of the downstream dam.
      2) OWNER will pay for and provide the necessary water for the initial wet performance test. If each dam does not successfully pass the wet performance test and requires additional testing, payment for the additional water required for subsequent testing will be the responsibility of the Manufacturer.
      3) Testing of the downstream dam shall be to ensure that the dam will operate as specified under both normal conditions

and during flood events. Testing of each downstream rubber dam shall be for the following specific performance requirements:

a) Lower the dam elevation from 1,148.0 feet to 1,147.8 feet and control the rubber dam elevation to within 1/2 inch of Elevation 1147.8 (using pressure as an indicator) for a duration of 1 hour. This test shall not be commenced until the pump back system has fully passed its performance test.

b) Partially deflate and inflate each rubber dam. Each rubber dam shall be deflated to a crest elevation of 1,145.0 feet and this elevation shall be maintained for a duration of 1 hour. There shall be no evidence of any damage to the rubber dam fabric and/or anchoring system.

END OF SECTION

SECTION 15060
PIPING–GENERAL

PART 1 GENERAL

1.1 SUBMITTALS

A. Quality Control Submittals:

1. Manufacturer's Certification of Compliance.
2. Certified welding inspection and test results.
3. Qualifications:
   a. Weld Inspection and Testing Agency: Certification and qualifications.
   b. Welding Inspector: Certification and qualifications.
   c. Welders:
      1) List of qualified welders and welding operators.
      2) Current test records for qualified welder(s) and weld type(s) for factory and field welding.
4. Weld Procedures: Records in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
5. Nondestructive inspection and testing procedures.
6. Manufacturer's Certification of Compliance:
   a. Pipe and fittings.
   b. Welding electrodes and filler materials.
   c. Factory applied resins and coatings.
7. Certified weld inspection and test reports.
8. Test logs.
9. Pipe coating applicator certification.

1.2 QUALITY CONTROL

A. Tests to be provided by OWNER and performed by independent inspection and testing agency for welding operations.

1.3 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01600, MATERIAL AND EQUIPMENT, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.
4. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.1 PIPING

A. As specified on Piping Data Sheet(s) located at the end of this section as Supplement.

B. Diameters Shown:

1. Standardized Products: Nominal size.
2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M-85.
3. Cement-Lined Steel Pipe: Lining inside diameter.

2.2 JOINTS

A. Flanged Joints:

1. Flat-faced carbon steel or alloy flanges when mating with flat-faced cast or ductile iron flanges.
2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.

B. Threaded Joints: NPT taper pipe threads in accordance with ANSI B1.20.1-83.

C. Thrust Tie-Rod Assemblies: In accordance with MAG Standard Details 302-1 and 302-2.

D. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276-94, Type 305 bands.
2. Manufacturers:
   a. Pipeline Products Corp.
   b. Ferno Joint Sealer Co.

2.3 COUPLINGS

A. Steel Middle Rings and Followers: Fusion bonded, epoxy-lined, and coated in accordance with Section 09900, PAINTING.

B. Flexible Couplings:

1. Manufacturers and Products:
   a. Steel Pipe:
      1) Dresser; Style 38.
      2) Smith-Blair; Style 411.
   b. Ductile Iron Pipe:
      1) Dresser; Style 153.
      2) Smith-Blair; Style 411.

C. Transition Couplings:

1. Manufacturers and Products:
   a. Dresser; Style 162.
   b. Smith-Blair; Style 413.

D. Flanged Coupling Adapters:

1. Manufacturers and Products:
   a. Steel Pipe:
      1) Smith-Blair; Series 913.
      2) Dresser Industries, Inc.; Style 128.
   b. Ductile Iron Pipe:
      1) Smith-Blair; Series 912.
      2) Dresser Industries, Inc.; Style 127.

2.4 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe manufacturer and no substitute or "or-equal" will be allowed.

2.5 VENT AND DRAIN VALVES

A. Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

2.6 FINISHES

A. Factory prepare, prime, and finish coat as stated herein.

B. Galvanizing:

1. Hot-dip applied, meeting requirements of ASTM A153-82.
2. Electroplated zinc or cadmium plating is unacceptable.
3. Stainless steel components may be substituted where galvanizing is specified.

2.7 PIPE FOR DRAINS BENEATH DAM

A. Solid and slotted PVC, Schedule 80, Type I, Grade 1, or Class 12454-B, conforming to ASTM D1784 and ASTM D1785.

B. All pipe surrounded with drain gravel shall be slotted at 90 degrees to the pipe axis. Slots shall be 0.040 inch wide by 2 inches long, with three slots equally spaced around the pipe perimeter. Slots shall be equally spaced along the pipe length with a maximum spacing of 1 inch. Alternate patterns shall be approved by the DESIGN ENGINEER prior to slotting pipe. All shavings shall be removed from the inside of the pipe and all slots shall be free of pipe shavings and open. Do not slot pipe at fittings.

2.8 FITTINGS

A. Schedule 80, as specified under PIPE hereinbefore. Fittings shall conform to the requirements of ASTM D2466 and ASTM D2467 for socket type.

2.9 SOLVENT CEMENT

A. All socket connections shall be joined with PVC solvent cement conforming to ASTM D2564. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

C. Welding Electrodes: Verify proper grade and type, free of moisture and dampness, and coating is undamaged.

3.2 PREPARATION

A. Notify RESIDENT ENGINEER at least 2 weeks prior to field fabrication of pipe or fittings.

B. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

C. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer's instructions.

3.3 WELDING

A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.1-92 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting manufacturer.

B. Weld Identification: Mark each weld with symbol identifying welder.

C. Pipe End Preparation:

1. Machine Shaping: Preferred.
2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
3. Beveled Ends for Butt Welding: ANSI B16.25-92.

D. Surfaces:

1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
2. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.

E. Alignment and Spacing:

1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
2. Root Opening of Joint: As stated in qualified welding procedure.
3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1 inch, whichever is greater.

F. Climatic Conditions: Do not perform welding if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 32 degrees F.

G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not *defective*. Remove those not meeting requirements prior to commencing welding procedures.

H. Surface Defects: Chip or grind out those affecting soundness of weld.

I. Weld Passes: As required in welding procedure.

J. Weld Quality: Free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity slag inclusions, and other defects in excess of limits shown in applicable piping code.

3.4 INSTALLATION–GENERAL

A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.

D. Threaded and Coupled Joints:

1. Conform with ANSI B1.20.1-83.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. Soldered Joints:

1. Use only solder specified for particular service.
2. Cut pipe ends square and remove fins and burrs.
3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
4. Wipe excess solder from exterior of joint before hardened.
5. Before soldering, remove stems and washers from solder joint valves.

F. Couplings:

1. General:
   a. Install in accordance with manufacturer's written instructions.
   b. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
   c. Do not remove pipe coating. If damaged, repair before joint is made.
2. Application:
   a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
   b. Nonmetallic Piping Systems: Teflon bellows connector.
   c. Concrete Encased Couplings: Sleeve type coupling.

G. Penetrations:

1. Watertight Penetrations:
   a. Provide wall pipes with thrust collars.
   b. Provide taps for stud bolts in flanges to be set flush with wall face.
2. Nonwatertight Penetrations:
   a. Pipe Sleeves With Seep Ring:
      1) Steel Pipe Sleeve:
         a) Material: 3/16-inch minimum thickness steel pipe.
         b) Seep Ring:
            (1) 3/16-inch minimum thickness center steel flange for water stoppage on sleeves in exterior or water-bearing walls.
            (2) Outside Diameter: 3 inches greater than pipe sleeve outside diameter.
            (3) Continuously fillet weld on each side all around.

c) Factory Finish:
(1) Galvanizing:
(a) Hot-dip applied, meeting requirements of ASTM A153-82.
(b) Electroplated zinc or cadmium plating is unacceptable.
(2) Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09900, PAINTING.

2) Insulated and Encased Pipe Sleeve:
a) Manufacturer: Pipe Shields, Inc.; Models WFB, WFB-CS and-CFW Series, as applicable.

b. Pipe sleeves with modular mechanical seal may be provided where fabrication of seep ring on pipe sleeve is impractical.

H. PVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.

I. Ductile Iron and Cement-Lined Ductile Iron Piping:

1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.
2. Dressing Cut Ends:
a. General: As required for the type of joint to be made.
b. Rubber Gasketed Joints: Remove sharp edges or projections.
c. Push-On Joints: Bevel, as recommended by pipe manufacturer.
d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.
3. Corrosion Protection Buried Pipe: Pipe, joints, fittings, and all other appurtenances shall be wrapped with loose polyethylene encasement and bedded in sand according to AWWA C105.
4. Corrosion Protection Exposed Pipe: Pipe, joints, fittings, and all other appurtenances shall be painted.

J. Carbon Steel Pipe:

1. Cut, makeup, and install pipe in accordance with pipe manufacturer's written instructions.
2. Corrosion Protection Buried Pipe: Tape wrap pipe, joints, fittings, and all other appurtenances (AWWA C209).
3. Corrosion Protection Submerged Pipe: Pipe, joints, fittings, and all other appurtenances in contact with water, coat with fusion-bonded epoxy (AWWA C213).
4. Corrosion Protection Exposed Pipe: Pipe, joints, fittings, and all other appurtenances shall be painted.

3.5 INSTALLATION–EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

C. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

D. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

E. Piping clearance, unless otherwise shown:

1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet 0 inch, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
3. From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
5. Head room in front of openings, doors, and windows shall not be less than the top of the opening.
6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.6 INSTALLATION–BURIED PIPE

A. Joints:

1. Dissimilar Buried Pipes:
   a. Provide flexible mechanical compression joints for pressure pipe.
   b. Provide concrete closure collar for gravity and low pressure (maximum 10 psi) piping or as shown.

2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete unless specifically shown.

B. Placement:

1. Keep trench dry until pipe laying and joining are completed.
2. Pipe Base and Pipe Zone: As specified in Section 02225, TRENCH BACKFILL.
3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
4. Measure for grade at pipe invert, not at top of pipe.
5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.
7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.
9. Install closure section and adapters for gravity piping at location where pipe laying changed direction.
10. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
    a. Shorter pipe lengths.
    b. Special mitered joints.
    c. Standard or special fabricated bends.
11. After joint has been made, check pipe alignment and grade.
12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
13. Prevent uplift and floating of pipe prior to backfilling.

C. Tolerances:

1. Deflection From Horizontal Line: Maximum 2 inches.
2. Deflection From Vertical Grade: Maximum 1/4 inch.
3. Joint Deflection: Maximum of 50 percent of manufacturer's recommendation.
4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
5. Pipe Cover: Minimum 2 feet 6 inches, unless otherwise shown.

3.7 THRUST RESTRAINT FOR POTABLE WATER PIPING

A. Location:

1. Buried Piping: At pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.
2. Exposed Piping: At all joints in pressure piping.

B. Thrust Ties:

1. Install where shown and as detailed.

2. Anchoring of retainer glands or thrust ties with setscrews is unacceptable.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint manufacturer's adapter gland follower and pipe end retainer, or thrust tie-rods and socket clamps.

3.8 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Wall Pipe Installation:

1. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations as specified in Section 09900, PAINTING.
2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie wires.

3.9 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:

1. Ductile Iron Piping: Connect only with service saddle or at a tapping boss of a fitting, valve body, or equipment casting.
2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.10 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines only where shown.

3.11 CLEANING

A. Following assembly and testing, and prior to final acceptance, flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. Blow clean of loose debris with compressed air at 4,000 fpm; do not flush with water.

C. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

D. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

E. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.12 FIELD FINISHING

A. Notify RESIDENT ENGINEER at least 3 days prior to start of any surface preparation or coating application work.

B. As specified in Section 09900, PAINTING.

3.13 PIPE IDENTIFICATION

A. See Section 02225, TRENCH BACKFILL.

3.14 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified in Section 15992, PIPING LEAKAGE TESTING.

B. Minimum Duties of Welding Inspector:

1. Job material verification and storage.
2. Qualification of welders.
3. Certify conformance with approved welding procedures.
4. Maintenance of records and preparation of reports in a timely manner.
5. Notification to RESIDENT ENGINEER of unsatisfactory weld performance within 24 hours of weld test failure.

C. Required Weld Examinations:

1. Perform examinations in accordance with the Piping Code, except that 5 percent of the circumferential butt welds shall be random radiographed.
2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for all piping covered by this section.
3. Examine at least one of each type and position of weld made by each welder or welding operator.
4. For each weld found to be *defective* under the acceptance standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the *defective* weld. Such additional examinations are in addition to the minimum required above. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

3.15 PIPE INSTALLATION FOR DRAINS BENEATH DAM

A. All rigid PVC pipe shall be cut and glued in accordance with the pipe manufacturer's recommendations. Plastic pipe shall be laid by gluing the pipe on the ground surface and lowering it into the pipe trench with ropes or slings.

B. Provide adequate ventilation when working with pipe joint solvent cement.

C. Place drain gravel to a level 6 inches above the top of the pipe and compact as specified. Excavate trenches for pipe and lay pipe to specified grade. Place drain gravel around pipe to a point 3 inches over top of pipe and compact as specified. Obtain RESIDENT ENGINEER's approval prior to placing drain gravel around pipe.

3.16 SUPPLEMENTS

A. Data Sheets.

Number	Title
-01	Cement-Mortar Asphaltic-Lined Ductile Iron Pipe and Fittings
-03	Carbon Steel Pipe and Fittings—General Service
-10	Polyvinyl Chloride (PVC) Pipe and Fittings

END OF SECTION

CEMENT-MORTAR LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Pipe	Buried Liquid Service Using Push-On, Mechanical, or Proprietary Restrained Joints: AWWA C110/A21.10-93, AWWA C115/A21.15-88, and AWWA C151/A21.51-91, thickness Class 52 minimum conforming to Table 51.7. Exposed Pipe Using Grooved End and Flange Joints: AWWA C115/A21.15-88, and AWWA C151/A21.51-91, thickness Class 53 minimum conforming to Table 51.7.
Lining	Cement-Mortar: AWWA C104/A21.4-90.
Fittings	Lined and coated same as pipe. Push-On: AWWA C110/A21.10-93 and C111/A21.11-90, gray or ductile iron, 250 psi minimum working pressure. American Cast Iron Pipe Co., Fastite Joint; U.S. Pipe and Foundry, Tyton Joint. Mechanical: AWWA C110/A21.10-93, C111/A21.11-90, and C153/A21.53-88 gray or ductile iron, 250 psi minimum working pressure. Proprietary Restrained: AWWA C111/A21.11-90 and C153/A21.53-88, ductile iron, 250 psi minimum working pressure. Clow Corp., Super-Lock Joint; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring Joint; U.S. Pipe, TR Flex. Flange: AWWA C110/A21.10-93, ductile or gray cast iron, faced and drilled, 125-pound flat face. Gray cast iron will not be allowed.
Joints	Push-On: 250 psi minimum working pressure, AWWA C110/A21.10-93 and C111/A21.11-90. American Cast Iron Pipe Co., Fastite Joint; U.S. Pipe and Foundry, Tyton Joint. Mechanical: 250 psi minimum working pressure. Proprietary Restrained: 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex. Flange: 125-pound flat face, 250-pound raised face, ductile iron, threaded conforming to AWWA C115/A21.15-88. Gray cast iron will not be allowed.
Couplings	Grooved End Adapter Flanges: 250-pound malleable iron per ASTM A47-90 or ductile iron per ASTM A536-84. Victaulic; Gustin-Bacon.

CEMENT-MORTAR LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Bolting	Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard. 125-Pound Flat-Faced Flange: ASTM A307-94, Grade A carbon steel hex head bolts and ASTM A563-93, Grade A carbon steel hex head nuts. 250-Pound Raised-Face Flange: ASTM A307-94, Grade B carbon steel hex head bolts and ASTM A563-93, Grade A carbon steel heavy hex head nuts.
Gaskets	Push-On, Mechanical, and Proprietary Restrained Joints: Rubber conforming to AWWA C111/A21.11-90. Grooved End Joints: Halogenated butyl conforming to ASTM D2000-90 and AWWA C606-87. Flanged, Water and Sewage Service: 1/8-inch thick, cloth-inserted rubber conforming to ANSI B16.21-92 and AWWA C207-86, corrosive acid and alkali free for potable water and sewage service, full face for 125-pound flat-faced flanges, nylon reinforced flat ring type for 250-pound raised-face flanges. Flanged, Fuel Gas Service: 1/8-inch thick, 1,500 psi minimum tensile strength, neoprene rubber, durometer 80, full face for 125-pound flat-faced flanges, flat ring type for 250-pound raised-face flanges. Garlock, Style 7797. Gasket pressure rating to equal or exceed the system hydrostatic test pressure.
Joint Lubricant	Manufacturer's standard.

CARBON STEEL PIPE AND FITTINGS–GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	All	Black carbon steel, ASTM A106-94, Grade B seamless or ASTM A53 Rev A-93, Grade B seamless or ERW. Threaded, butt-welded, and flanged joints:
	Welded:	
	2" & smaller	Schedule 80.
	2-1/2" thru 10"	Schedule 40.
	12" thru 16"	Schedule 30.
	18" thru 24"	Schedule 20.
	Grooved:	
	2-1/2" thru 6"	Schedule 40.
	8" thru 12"	Schedule 30.
	14"	Standard weight.
Joints	2" & smaller	Threaded or flanged at equipment as required.
	2-1/2" & larger	Butt-welded or flanged at valves and equipment, or grooved end meeting the requirements of AWWA C606-87.
Fittings	2" & smaller	Threaded: 150- or 300-pound malleable iron, ASTM A197-87 or ASTM A47-90, dimensions in accordance with ANSI B16.3-92. Fire sprinkler fittings to be UL listed.
	2-1/2" & larger	Butt Welded: Wrought carbon steel butt-welding, ASTM A234/A234M-94, Grade WPB meeting the requirements of ANSI B16.9-93; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise. Grooved End: Malleable iron ASTM A47-90 or ductile iron ASTM A536-84, grooved ends to accept couplings without field preparation. Victaulic; Gustin-Bacon.
Branch Connections	2" & smaller	Threaded, straight, or reducing tees in conformance with Fittings specified above.
	2-1/2" & larger	Butt-welding or grooved end tee in conformance with Fittings specified above.

CARBON STEEL PIPE AND FITTINGS–GENERAL SERVICE		
Item	**Size**	**Description**
Flanges	2" & smaller	Forged carbon steel, ASTM A105/A105M-94, Grade II, ANSI B16.5-88 Class 150 or Class 300 socket-weld or threaded, 1/16-inch raised face.
	2-1/2" & larger	Butt-Welded Systems: Forged carbon steel, ASTM A105/A105M-94, ANSI B16.5-88 Class 150 or Class 300 slip-on or welding neck, 1/16-inch raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Grooved End Adapter Flange: Malleable iron ASTM A47-90 or ductile iron ASTM A536-84. Victualic; Gustin-Bacon. Cast Iron Mating Flange: AWWA C207-86, Class D or E, hub or ring type, ANSI B16.1-89, 125-pound drilling, AWWA C207-86 Class F hub type or ASTM A105/A105M-94, ANSI B16.5-88 Class 300-pound, drilling.
Unions	2" & smaller	Threaded malleable iron, ASTM A197-88 or A47-90, 150- or 300-pound WOG, meeting the requirements of ANSI B16.3-92.
Couplings	2-1/2" & larger	Grooved End: Rigid joint malleable iron, ASTM A47-90 or ductile iron, ASTM A536-84. Victaulic; Gustin-Bacon. Screwed End: Malleable iron, ASTM A197-88 or A47-90.
Bolting	All	Flanges: Carbon steel ASTM A307-94, Grade A hex head bolts and ASTM A563-93, Grade A hex head nuts. Use 1/8-inch undersize bolting material for insulating flanges. Grooved End Couplings: Carbon steel, ASTM A183-83 bolts and nuts, 110,000 psi minimum tensile strength.

CARBON STEEL PIPE AND FITTINGS–GENERAL SERVICE		
Item	**Size**	**Description**
Gaskets	All flanges	General Service, Oil and Gas: 1/16-inch thick compressed nonasbestos composition flat ring type. Garlock, Style 3000; Manville, Style 978. Water and Sewage Service: 1/8-inch cloth-inserted rubber, nylon reinforced over 150 psi service pressure, corrosive acid and alkali free, suitable for potable water where applicable, conforming to ANSI B16.21-92 and AWWA C207-86. Grooved Couplings: EPDM per ASTM D2000 for water and air to 230 degrees F, nitrile for oil service to 180 degrees F. Chlorine Unions: Chemical lead, 2 to 4 percent antimony, 1/8-inch thick.
Thread Lubricant	2" & smaller	General Service: Teflon tape.

POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Pipe	All	Schedule 40 and Schedule 80: Type I, Grade I or Class 12454-B conforming to ASTM D1784-92 and ASTM D1785-93. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule 40 and Schedule 80 as Specified Under Pipe Above: ASTM D2466-94 and ASTM D2467-93 for socket-weld type and ASTM D2464-93 for threaded type.
Joints	All	Solvent socket-weld except where connection to valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1-89 drilling
Bolting	All	Flat Face Mating Flange or In Corrosive Areas: ASTM A193/A193M Rev A-94 Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M-94 Grade 8M hex head nuts. With Raised Face Mating Flange: Carbon steel ASTM A307-94 Grade B square head bolts and ASTM A563-93 Grade A heavy hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564-93.
Thread Lubricant	All	Teflon Tape.

SECTION 15100
VALVES AND OPERATORS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Product data sheets for make and model.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

B. Quality Control Submittals:

1. Certificate of Compliance for butterfly valves; full compliance with AWWA C504.
2. Tests and inspection data.
3. Manufacturer's Certificate of Proper Installation.
4. Operation and maintenance manual.

PART 2 PRODUCTS

2.1 GENERAL

A. Valve to include operator, actuator, handwheel, extension stem, operator, operating nut, wrench, and accessories for a complete operation.

B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve same size as adjoining pipe.

D. Valve ends to suit adjacent piping.

E. Size operator to operate valve for the full range of pressures and velocities.

F. Valve to open by turning counterclockwise.

G. Factory mount operator, actuator, and accessories.

2.2 MATERIALS

A. Brass and bronze valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.

B. Approved alloys are of the following ASTM designations:

1. B61, B62, B98 (Alloy UNS No. C65100, C65500, or C66100), B139 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
2. Stainless steel Alloy 18-8 may be substituted for bronze.

2.3 FACTORY FINISHING

A. Exposed Valves: In accordance with Section 09900, PAINTING.

2.4 VALVES

A. Gate Valves:

1. Type V100 Gate Valve 3 Inches and Smaller: All-bronze, screwed bonnet, single solid wedge gate, nonrising stem, rated 125-pound SWP, 200-pound WOG.
   a. Manufacturers and Products:
      1) Stockham; B103, threaded end.
      2) Crane; 438, threaded end.
      3) Stockham; B104, soldered end.
      4) Crane; 1324, soldered end.
2. Type V130 Resilient Seated Gate Valve 3-Inch to 12-inch:
   a. Iron body, resilient seat, bronze mounted, flanged ends, nonrising stem in accordance with AWWA C509, rated 200 psi cold water, full port, fusion epoxy-coated inside and outside.
   b. Coating to meet requirements of AWWA C550.

B. Globe Valves:

1. Type V235 Angle Type Hose Valve: 3/4-inch NPT female inlet, 3/4-inch male hose thread outlet, heavy rough brass body rated 125 psi, lockshield bonnet, removable handle, atmoshperic vacuum breaker conforming to ASSE Standard 1011 and IAMPCO code.
   a. Manufacturer and Product:
      1) Acorn; 8131, pipe and pedestal mounted valve located above 6 inches, straightnose.

C. Butterfly Valves:

1. General: Butterfly valve specified as AWWA C504 to be in compliance with AWWA C504 and following requirements:
   a. Suitable for throttling operations and infrequent operation after periods of inactivity.
   b. Elastomer seats bonded or vulcanized to body shall have adhesive integrity of bond between seat and body assured by testing with minimum 75-pound pull in accordance with ASTM D429, Method B.
   c. Bubble-tight with rated pressure applied from either side.
   d. No travel stops for the disc on interior of the body.
   e. Self-adjusting V-type or O-ring shaft seals.
   f. Isolate metal-to-metal thrust bearing surfaces from flowstream.

2. Type V501 Butterfly Valve:
   a. Flanged end, short body type.
   b. AWWA C504, Class 25.

D. Check and Flap Valve:

1. Type V612 Double Disc Swing Check Valve:
   a. Wafer style, spring loaded, cast or ductile iron body, aluminum-bronze or ductile iron doors, resilient seats, stainless steel hinge pin, stop pin spring.
   b. Valve 2 inches through 12 inches rated 200-pound cold water and valve 14 inches through 54 inches rated 150-pound cold water.
   c. Manufacturers and Products:
      1) Stockham; 970.
      2) APCO; Series 9000.
2. Type V690 Flap Gate:
   a. Cast iron body, bronze mounted, flanged frame type, dual pivot-point hinge arms, hinge arms bronze, hinge pins Type 304 stainless steel, seat bronze and impacted into grooves in body and cover flap, lubrication fittings for each pivot, Type 316 stainless steel anchor bolts or cast iron wall thimble.

2.5 OPERATORS

A. Manual Operator:

1. General:
   a. Operator force not to exceed 40 pounds under any operating condition, including initial breakaway. Gear reduction operator when force exceeds 40 pounds.
   b. Operator self-locking type or equipped with self-locking device.
   c. Position indicator on quarter-turn valves.
   d. Worm and gear operators one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type operators threader steel reach rods with internally threaded bronze or ductile iron nut.
2. Exposed Operator:
   a. Galvanized and painted handwheels.
   b. Lever operators allowed on quarter-turn valves 8 inches and smaller.
   c. Extension stem, torque tubes, and other accessories to permit operation from normal operation level as shown on the Drawings.
   d. Valve handles to take a padlock, and wheels a chain and padlock.

B. Electric Operator:

1. General:
   a. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of valve.
   b. Controls integral with the actuator and fully equipped.

c. Stem protection for rising stem valves.

2. Actuator Operation—General:
   a. Suitable for full 90-degree rotation of quarter-turn valves or for use on multiturn valves.
   b. Manually override handwheel.
   c. Valve position indication.
   d. Operate from FULL CLOSED to FULL OPEN positions or the reverse.
3. Open-Close: Size motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes.
4. Actuator Power Supply: 120-volt, single-phase unless otherwise indicated.
5. Enclosure: As defined in NEMA 250, Type 4.
6. Limit Switch:
   a. Single-pole, double-throw (SPDT) type, field adjustable cam-operated, with contacts rated for 5 amps at 120 volts ac.
   b. Each valve actuator to have a minimum of two transfer contacts at end position, one for valve FULL OPEN and one for valve FULL CLOSED.
   c. Housed in actuator control enclosure.
7. Manufacturers and Products:
   a. Raymond Control System.
   b. Flo-Tork.

2.6 ACCESSORIES

A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag for each valve operator, bearing the valve tag number shown on the Electric Operator Schedule.

B. Limit Switch:

1. Factory installed limit switch by actuator manufacturer.
2. SPST, rated at 5 amps, 120 volts ac.

C. Extension Bonnet for Valve Operator: Complete with stem and accessories for valve and operator.

D. Cast Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 6-inch ID shaft.

1. Box: Cast iron with minimum depth of 9 inches.
2. Lid: Cast iron, minimum depth 3 inches, marked WATER.
3. Extensions: Cast iron, ABS, or PVC pipe.

PART 3 EXECUTION

3.7 INSTALLATION

A. Flange Ends:

1. Flanged valve boltholes shall straddle vertical centerline of pipe.

2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:

1. Clean threads by wire brushing or swabbing.
2. Apply joint compound.

C. Valve Orientation:

1. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
2. Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above finish floor, unless otherwise shown.
3. Orient butterfly valve shaft so that unbalanced flows or eddies are equally divided to each half of the disc, i.e., shaft is in the plane of rotation of the eddy.

D. Locate valve to provide accessibility for control and maintenance.

3.8 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.

C. Count and record number of turns to open and close valve; account for any discrepancies with manufacturer's data.

3.9 MANUFACTURER'S FIELD SERVICES

A. The valve(s) as listed below require manufacturer's field services:

1. V501 and V612.

B. Manufacturer's Representative: Present at site for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

C. See Section 01640, MANUFACTURERS' FIELD SERVICES and Section 01650, FACILITY STARTUP.

END OF SECTION

SECTION 15500
HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that include make, model, dimensions, weight of equipment, and electrical schematics for products specified.
2. Complete performance data that indicates full compliance with the Specifications.
3. Recommended procedures for protection and handling of equipment and materials prior to installation.

B. Quality Control Submittals:

1. For motors specified to be energy efficient type, certified copy of test report for identical motor tested, in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B, showing full load efficiency.
2. Recommended procedures for protecting and handling of equipment and materials prior to installation.
3. Operation and maintenance manuals.
4. List of recommended spare parts for equipment and materials specified.

PART 2 PRODUCTS

2.1 GENERAL

A. Fans shall have sound power level data (ref. 10 to -12 watts) at design operating point; ratings shall be based on AMCA Bulletin 300, Setup No. 1.

2.2 EVAPORATIVE COOLING UNIT

A. Supply Unit Assembly:

1. Supply fan.
2. Water distribution system.
3. Recirculation pump.
4. Float valve.
5. Pads.
6. Motor and drive.
7. Contained in a hot dip galvanized, weatherproof steel casing.
8. Junction box for all electrical connections.

9. UL or ETL listed.

B. Enclosure:

1. Fabricate enclosure panels and drain pan of 16-gauge hot dip galvanized steel.
2. Epoxy baked paint inside and out.
3. Flush mount panels into the unit framework.
4. Furnish access panels for maintenance of fan, motor, water distribution system, and filters.
5. Furnish drain pan with drain piping.

C. Fan:

1. Double-inlet, double-width centrifugal fan.
2. Forward-curved blades.
3. Mounted with grease-lubricated, self-aligning ball bearings.
4. Fan and drive assembly mounted on rubber isolators.

D. Pump:

1. Single-phase motor, 115-volt.
2. 600 gallons per hour capacity.
3. Piped for continuous bleed operation.

E. Pads:

1. 12-inch thick, cross fluted design.
2. Glass fiber construction bonded with inorganic, noncrystalline fillers.
3. PVC water distributor tubes.

F. Electrical Equipment:

1. Single point 460-volt, three-phase connection. Provide transformer as required for pump and control power.
2. Two-speed magnetic starter.
3. NEMA 4 enclosure.

G. Remote Control Enclosure:

1. Six-position control switch with OFF/LO VENT/HIGH VENT/LO COOL/HIGH COOL/PUMP ONLY.
2. Locate controls as shown.
3. PVC water distributor tubes.

H. Upstream Dam Operations Building Capacity: 4,200 cfm standard air at 0.3-inch external static pressure, maximum water usage of 0.30 gpm/ 1,000 cfm, cool air at 109 degrees F DB and 71 degrees F WB down to 77 degrees F DB, 2,600-fpm maximum outlet velocity. 3/4-hp motor, two-speed, 460-volt, three-phase.

I. Downstream Dam Operations Building Capacity: 13,600 cfm standard air at 0.8-inch external static pressure, maximum water usage of 0.30 gpm/ 1,000 cfm, cool air at 109 degrees F DB and 71 degrees F WB down to 77 degrees F DB, 2,600-fpm maximum outlet velocity. 5-hp motor, two-speed, 460-volt, three-phase.

J. Manufacturer and Product:

1. United Metal Products; Model Fan-Air, CB.
2. Or equal.

2.3 EQUIPMENT ACCESSORIES

A. Equipment Identification Plates: Provide 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch high die-stamped block type equipment identification number indicated in this Specification and as shown.

B. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

2.4 DUCTWORK

A. Metal:

1. Material: ASTM A525-91a, G60, galvanized steel, thickness in accordance with UMC.
2. Fabricate in accordance with UMC 10-1.
3. Duct sizes shown are net air side face-to-face dimensions required.

2.5 SUPPLY REGISTERS

A. Rectangular aluminum construction.

B. Individually adjustable horizontal face and vertical rear louver fins.

C. Gang-operated opposed-blade horizontal volume control damper.

D. Continuous sponge rubber gasket at face flange.

E. 1-inch flat aluminum frame.

F. Prime coat finish.

G. Manufacturers and Products:

1. Krueger; Model 5880H-OBD.
2. Carnes; Type RNDAH.

2.6 DUCT ACCESSORIES

A. Elbows:

1. Rectangular:
   a. Fit square-turn elbows with vane side rails.
   b. Shop fabricated double-blade turning vanes of same material as ductwork.
   c. Fabricate with equal inlet and outlet.
   d. Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.
   e. Manufacturers and Products:
      1) Elgen: All-Tight.
      2) Duro-Dyne; Type TR.
2. Round: Furnish with centerline radius of 1.5 times duct diameter.

B. Flexible Connections to Noninternally Spring-Isolated Rotating Fan Equipment:

1. Furnish neoprene-coated, fire-resistant glass fabric, with 2-inch minimum clearance between casing and ductwork.
2. Coat outdoor flexible connectors with Hypalon for UV protection.
3. Manufacturers and Products.
   a. Ventfabrics; Ventlas.
   b. Duro-Dyne; Durolon.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment and systems in accordance with manufacturers' instructions.

B. Fans and Air Handlers:

1. Isolate sheet metal duct connections from noninternally spring-isolated fan units or other rotating equipment.
2. Locate units approximately where shown to provide access spaces required for filter changing; motor, drive, and bearing servicing; and fan shaft and coil removal.
3. Inspect internal casing insulation, seal exposed edges, and butt joints with mastic to ensure insulation will not be loosened during operation.

C. Ductwork:

1. Install sheet metalwork, ductwork, and supports in accordance with UMC.
2. Cross-break horizontal surfaces of rectangular metal ducts.
3. Install additional bracing as required to prevent ballooning or breathing.
4. For interior ductwork, tape joints with Hardcast Lag-Rite tape and bonder or Ray-Chem shrink tape. For exterior ductwork, tape joints

with Hardcast outdoor tape and rosin. Tape joints according to the following table:

Pressure Class	Sealing Required
2-inch WC or less	Transverse joints
>2-inch WC	Transverse joints and longitudinal seams

5. Seal joints of ductwork.
6. Provide balancing dampers for grilles and diffusers in the branch duct as near the main as possible. Add or remove balancing dampers as requested by the air balancing firm for necessary control of air.
7. Make duct size transitions with the maximum inclusive angle of 30 degrees, unless otherwise indicated on the Drawings.
8. Make offsets with maximum angle of 45 degrees.

D. Install diffusers, grilles, and registers tight on their respective mounting surfaces, plumb and true with room dimensions.

E. Provide appropriate frame to adapt to mounting surface.

3.2 AIR HANDLING

A. Shafts and Drive Belts:

1. Belt Guards: Meet federal and State of Nevada OSHA requirements for safety protection, and be easily removable by one person.
2. Tachometer Access Holes: Large enough to accept standard tachometer drive shaft.
3. Centerpunch fan shaft to accommodate tachometer readings.

B. Vibration:

1. Statically and dynamically balance fan equipment.
2. If vibration limits are exceeded, rebalance equipment in-place, if directed by RESIDENT ENGINEER, until design tolerances are met.

C. Fan Equipment: Rated and tested in accordance with AMCA Standards 210 and 2401 for Class I service, unless otherwise specified.

D. Drives for Belt-Driven Fans:

1. Sheaves shall be capable of providing 150 percent of motor horsepower.
2. Motors shall be mounted on adjustable motor brackets.
3. Motors 10 hp and under shall be provided with adjustable speed sheaves that allow for 20 percent speed variation.
4. Belt-driven fans shall be provided with cast iron or flanged steel sheaves.

E. Air Filters, Fans, Air Handlers, and Air Conditioners: Meet requirements of NFPA No. 90A or No. 90B.

3.3 ADJUSTING AND BALANCING

A. Adjust and balance air systems in accordance with standard procedures and recognized practices of the Association of Air Balance Council or the SMACNA "HVAC Testing, Adjusting, and Balancing Manual."

B. Adjust air volumes on supply diffusers and grilles, and on return and exhaust grilles, to the quantity shown, with allowable variation of plus 10/minus 0 percent.

C. In each system at least one air path from fan to final branch duct termination shall have dampers fully open. Achieve final air quantities by adjusting fan speed.

D. Adjust Fan Air Volumes:

1. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation of plus 10/minus 0 percent.
2. After final adjustments, do not operate motor above nameplate amperage on any phase.
3. Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust, and full return air.
4. Furnish and make drive and belt changes on motors or fans as required to adjust equipment to specified conditions. Provide written notice to the air handling unit manufacturer if any drive or belt changes were made.

E. Adjust outside air dampers, return air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.

F. Read and record static pressures at unit inlet and discharge, filters, coils, dampers, plenums, on every supply, fan.

G. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.

3.4 FIELD QUALITY CONTROL

A. Report Requirements:

1. Record information from tests, readings, and adjustments necessary to accomplish the services described. In addition, record the following data:
   a. Equipment identification number.
   b. Equipment nameplate data (including manufacturer, model, size, type, and serial number).
   c. Motor data (frame, hp, volts, FLA and rpm).
   d. Sheave and belt size.
   e. Starter and heater data.
2. Include a reduced set of Mechanical Drawings in the balance log showing the final airflow readings for each system.

3. Include a separate section in the log, if necessary, that describes any operating difficulties in the air system that could not be eliminated by the specified procedures. Identify these problems by system and location within the building, include an outline of a summary of the condition and its effect on the building, and describe corrective action attempted.

B. Quality Control Verification: After adjustments have been completed and the balance logs submitted, the balancing and testing agency shall be available to demonstrate the air balancing procedures and vibration tests, and verify the test results.

END OF SECTION

SECTION 15992
PIPING LEAKAGE TESTING

PART 1 GENERAL

1.1 SUBMITTALS

A. Quality Control Submittals:

1. Testing Plan: Submit prior to testing and include at least the information that follows.
   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Test type.
   d. Method of isolation.
   e. Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

A. All pipe and appurtenances shall successfully pass a hydrostatic test prior to acceptance and shall be free of visible leakage.

3.2 PREPARATION

A. Notify RESIDENT ENGINEER in writing 7 days in advance of testing. Perform testing in presence of RESIDENT ENGINEER.

B. Furnish all testing equipment and water and make all taps in the pipe to perform the test in a manner satisfactory to the RESIDENT ENGINEER.

C. Gauges for testing shall be calibrated with a standardized test gauge provided by RESIDENT ENGINEER at the start of each testing day. The calibration shall be witnessed by the RESIDENT ENGINEER.

D. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

4. Potable Water Piping Test Pressure: 125 psi.
5. All Other Piping Test Pressure: 25 psi.

E. Test section may be filled with water and allowed to stand under low pressure prior to testing.

F. Gravity Piping:

1. Perform testing after manholes, and backfilling have been completed between stations to be tested.
2. Pipe 42-Inch Diameter and Larger Piping: Joint testing device may be used to isolate and test individual joints.

3.3 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets,.
4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.
7. Empty pipe of water prior to final cleaning or disinfection.

C. Buried Piping:

1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage:

$$L = \frac{SD(P)^{1/2}}{133{,}200}$$

where:

L = Allowable leakage, in gallons per hour.
S = Length of pipe tested, in feet.
D = Nominal diameter of pipe, in inches.
P = Test pressure during leakage test, in pounds per square inch.

7. Correct leakage greater than allowable, and retest as specified.

D. Defective Piping Sections: Replace and retest as specified.

3.4 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2 gallon of water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.5 gallon per hour per inch diameter per 100 feet.

C. Exfiltration Test:

1. Hydrostatic Head:
   a. At least 6 feet above maximum estimated groundwater level in section being tested.
   b. No less than 6 feet above inside top of highest section of pipe in test section.
2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

D. *Defective* Piping Sections:

1. Repair or replace and retest.
2. Submit proposed method for review prior to starting any repair work.

3.5 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Remarks, including:
   a. Leaks (type, location).
   b. Repair/replacement performed to remedy excessive leakage.
6. Signed by CONTRACTOR and RESIDENT ENGINEER to represent that test has been satisfactorily completed.

END OF SECTION

SECTION 16010
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 16, ELECTRICAL. Work specified herein shall be performed as if specified in the individual sections.

1.2 DESIGN REQUIREMENTS

A. All equipment anchoring and mounting shall be in accordance with manufacturer's requirements for the seismic zone criteria given in Section 01600, MATERIALS AND EQUIPMENT.

1.3 ELECTRICAL COORDINATION

A. Work Provided Outside this Contract:

1. Details of facility equipment and construction for all Specification Divisions which affect work covered under Division 16, ELECTRICAL.
2. Incoming underground power cables, materials, installation, termination, and connection. Under this Contract, provide trench, backfill, and duct system.
3. Transformers supplying main electrical service to the facility; site preparation and transformer pad(s) included in this Contract.
4. Utility primary switch cabinets; box pads furnished by utility, installed under this contract.
5. Power company metering facilities, except as indicated.
6. Incoming telephone service, as indicated.
7. Interior telephone system, except as indicated.
8. CATV duct and pullboxes provided by Cox Cable, installed under this Contract.

B. Primary and Secondary Electric Service:

1. Provide in accordance with Arizona Public Service (APS) Design Documents.
2. CONTRACTOR shall obtain all relevant design documents, drawings, specifications, details, instructions, and standards from APS.

1.4 SUBMITTALS

A. Quality Control Submittals:

1. Voltage Field Test Results.
2. Voltage Balance Report.

3. Equipment Line Current Report.
4. Factory test certification and reports for all major electrical equipment.
5. Site test certification and reports as specified in other Division 16, ELECTRICAL sections.
6. City agent to be present during field testing.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide materials and equipment listed by UL wherever standards have been established by that agency.

B. Equipment Finish:

1. Provide manufacturers' standard finish and color, except where specific color is indicated.
2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.

PART 3 EXECUTION

3.1 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

C. All work shall be in accordance with the City of Tempe Electrical Code and all other applicable state or local codes.

3.2 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.3 CHECKOUT AND STARTUP

A. Voltage Field Test:

1. Check voltage at point of termination of power company supply system to project when installation is essentially complete and is in operation.
2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
3. Record supply voltage (all three phases simultaneously on the same graph) for 24 hours during normal working day.
   a. Submit Voltage Field Test Report within 5 days of test.
4. Unbalance Corrections:
   a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
   b. Obtain a written certification from a responsible power company official that the voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
3. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

END OF SECTION

SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Junction and pull boxes used at, or below, grade, or embedded in concrete.
2. Terminal junction boxes.
3. Panelboards and circuit breaker data.
4. Fuses.
5. Contactors and relays.
6. Transformers.
7. Service entrance and disconnect equipment.
8. Instruments and control components.
9. Telemetry panel.

B. Quality Control Submittals for Instruments and Control Components:

1. Factory functional test reports.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer's printed installation instructions.
4. Field test reports.
5. Manufacturer's Certification of Proper Installation.
6. Suggested spare parts list to maintain equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Operation and maintenance manual.

1.2 QUALITY ASSURANCE

A. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

B. Hazardous Areas: Materials and devices shall be specifically approved for hazardous areas of the class, division, and group shown and of a construction that will ensure safe performance when properly used and maintained.

1.3 SPARE PARTS

A. Furnish, tag, and box for shipment and storage and deliver prior to 90 percent Project completion the following spare parts:

1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed.

PART 2 PRODUCTS

2.1 METERING AND SERVICE DISCONNECT FACILITIES

A. Furnish materials as required by electric utility for utility's installation of metering equipment, service conductors, and mounting of utility company equipment.

B. Service Disconnect:

1. Provide cabinet in accordance with utility requirements.
2. Static Trip Circuit Breaker:
   a. In accordance with NEMA AB 1 and UL 489.
   b. Main protective device.
   c. UL labeled as suitable for service entrance.
   d. Molded case breaker with ambient insensitive solid-state trip and having current sensors and logic circuits integral in breaker frame.
   e. Solid-state current control with adjustable ampere setting, adjustable long-time delay, adjustable short-time trip and delay band, fixed instantaneous trip set at 15 times current sensor rating and adjustable ground fault trip and delay band.
   f. Setting adjustments to be covered by a sealable, tamper-proof, transparent cover.
   g. Locate trip button on front cover of breaker to permit mechanical simulation overcurrent tripping for test purposes and to trip breaker quickly in an emergency situation.

2.2 INSTRUMENTS AND COMPONENTS

A. Provide instruments and components as shown and as specified in Supplement, COMPONENT SPECIFICATIONS.

2.3 TELEMETRY PANEL

A. General: Provide telemetry panels, as shown, to terminate control and signal wiring and to house future telemetry equipment.

B. Construction:

1. 36 inches high by 30 inches wide by 12 inches deep, minimum.
2. Wall mount, NEMA 12, 14GA steel, minimum.
3. Single, continuous hinge door with quarter turn latches.
4. Back panel, white.
5. Stainless steel hardware.
6. ANSI 61 gray powder coat over phosphatized surfaces, inside and out.

C. Features:

1. Provide sufficient terminal blocks to terminate all wiring shown, plus a minimum of 50 spare terminal points.
2. Locate terminal blocks across the lower part of the panel, approximately 6 inches above the bottom edge.
3. Maintain a minimum 24-inch by 24-inch panel area clear for future equipment.

D. Manufacturers:

1. Hoffman Engineering Co.
2. Robroy Industries.

2.4 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.

B. Cast Metal:

1. Box: Malleable iron.
2. Cover: Gasketed, weatherproof, malleable iron, with stainless steel screws.
3. Hubs: Threaded.
4. Lugs (Cast Mounting) Manufacturer:
   a. Crouse-Hinds; Type FS or FD.
   b. Appleton; Type FS or FD.

C. PVC-Coated Sheet Steel:

1. Type: One-piece.
2. Material: Zinc- or cadmium-plated.
3. Coating: All surfaces; 40-mil PVC.
4. Manufacturer: Appleton.

D. Nonmetallic:

1. Box: PVC.
2. Cover: PVC, weatherproof, with stainless steel screws.
3. Manufacturer: Carlon; Type FS or FD, with Type E98 or E96 covers.

2.5 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Article OUTLET AND DEVICE BOXES.

B. Large Sheet Steel Box: NEMA 250, Type 1.

1. Box: Code-gauge, galvanized steel.
2. Cover: Full access, hinged type.
3. Machine Screws: Corrosion-resistant.

C. Large Cast Metal Box: NEMA 250, Type 4.

1. Box: Cast malleable iron, hot-dip galvanize finished, with drilled and tapped conduit entrances.
2. Cover: Nonhinged with screws.
3. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
4. Manufacturers, Surface Mounted Type:
   a. Crouse-Hinds; Series W.
   b. O.Z./Gedney; Series Y.
5. Manufacturers, Recessed Type:
   a. Crouse-Hinds; Type WJBF.
   b. O.Z./Gedney; Series YR.

D. Large Steel Box: NEMA 250, Type 1 or 12.

1. Box: 12-gauge steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces, with final ANSI Z55.1, No. 61 gray enamel on exterior surfaces.
2. Cover: Hinged with screws.
3. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
4. Manufacturers:
   a. Hoffman Engineering Co.
   b. Robroy Industries.

E. Concrete Box: See Section 16110, RACEWAYS.

2.6 WIRING DEVICES

A. Switches:

1. NEMA WD 1 and FS W-S-896E.
2. Specification grade, totally-enclosed, ac type, with quiet tumbler switches and screw terminals.
3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
4. Rating: 20 amps, 120/277 volts.
5. Color:
   a. Office Areas: Ivory.
   b. Other Areas: Brown.
6. Manufacturers:
   a. Bryant.
   b. Leviton.
   c. Hubbell.
   d. Pass and Seymour.
   e. Arrow Hart.

B. Receptacle, Single and Duplex:

1. NEMA WD 1 and FS W-C-596.

2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
3. High strength, thermoplastic base color.
4. Color:
   a. Office Areas: Ivory.
   b. Other Areas: Brown.
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
7. Manufacturers:
   a. Bryant.
   b. Leviton.
   c. Hubbell.
   d. Pass and Seymour.
   e. Sierra.
   f. Arrow Hart.

C. Receptacle, Ground Fault Circuit Interrupter: Duplex, specification grade, tripping at 5 mA.

1. Color: Brown.
2. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, capable of interrupting 5,000 amps without damage.
3. Size: For 2-inch by 4-inch outlet boxes.
4. Standard Model: NEMA WD 1, with screw terminals and provisions for testing.
5. Feed-Through Model: NEMA WD 1, with feed-through screw terminals and provisions for testing.
6. Manufacturers:
   a. Pass and Seymour.
   b. Bryant.
   c. Leviton.
   d. Hubbell.
   e. Arrow Hart.

2.7 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Plastic:

1. Material: Specification grade, 0.10-inch minimum thickness, noncombustible, thermosetting.
2. Color: To match associated wiring device.
3. Mounting Screw: Oval-head metal, color matched to plate.

C. Metal:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

D. Cast Metal:

1. Material: Malleable ferrous metal, with gaskets.
2. Screw: Oval-head stainless steel.

E. Weatherproof:

1. For Receptacles: Gasketed, cast metal or stainless steel, with individual cap over each receptacle opening.
   a. Mounting Screw: Stainless steel.
   b. Cap Spring: Stainless steel.
   c. Manufacturers:
      1) General Electric.
      2) Bryant.
      3) Hubbell.
      4) Sierra.
      5) Pass and Seymour.
      6) Crouse-Hinds; Type WLRD or WLRS.
      7) Bell.
      8) Arrow Hart.
2. For Switches: Gasketed, cast metal incorporating external operator for internal switch.
   a. Mounting Screw: Stainless steel.
   b. Manufacturers:
      1) Crouse-Hinds; DS-181 or DS-185.
      2) Appleton; FSK-1VTS or FSK-1VS.

F. Raised Sheet Metal: 1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel boxes.

2.8 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. NEMA PB 1, NFPA 70, and UL 67, including panelboards installed in motor control equipment.

B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

D. Rating: Applicable to a system with available short-circuit current of 22,000 amperes rms symmetrical at 208Y/120 or 120/240 volts and 22,000 amperes rms symmetrical at 480Y/277 volts.

E. Ground Fault Interrupter: 5 mA trip, 10,000 amps interrupting capacity circuit breakers.

F. Cabinet: NEMA 250, Type 1, General Use, unless otherwise shown.

1. Material: Code-gauge, hot-dip galvanized sheet steel, with reinforced steel frame.

2. Wiring Gutter: Minimum 4-inch square; both sides, top and bottom.
3. Front: Fastened with adjustable clamps.
   a. Trim Size:
      1) Surface Mounted: Same as box.
      2) Flush Mounted: 3/4-inch larger than box on all sides.
   b. Finish: Rust inhibitor prime, with manufacturer's standard baked enamel or lacquer.
4. Interior:
   a. Factory assembled, complete with circuit breakers.
   b. Capable of circuit breaker replacement without disturbing adjacent circuit breakers or without removing main bus.
   c. Spaces: Cover openings with easily removable metal cover.
5. Door Hinges: Concealed.
6. Locking Device:
   a. Flush type.
   b. Doors Over 30 Inches in Height: Multipoint.
   c. Identical keylocks, with two milled keys each lock.
7. Circuit Directory: Metal frame with transparent plastic face and enclosed card on interior of door.

G. Bus Bar:

1. Material: Copper, full sized throughout length.
2. Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.
3. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
4. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
5. Lugs and Connection Points:
   a. Suitable for either copper or aluminum conductors.
   b. Solderless main lugs for main, neutral, and ground bus bars.
   c. Subfeed or through-feed lugs as shown.
6. Bolt together and rigidly support bus bars and connection straps on molded insulators.

H. Circuit Breakers:

1. NEMA AB 1 and UL 489.
2. Thermal-magnetic, quick-make, quick-break, molded case, of the indicating type showing ON/OFF and TRIPPED positions of operating handle.
3. Noninterchangeable, in accordance with NFPA 70.
4. Locking: Provisions for handle padlocking, unless otherwise shown.
5. Type: Bolt-on.
6. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
7. Do not substitute single-pole circuit breakers with handle ties for multipole breakers.
8. Do not use tandem or dual circuit breakers in normal single-pole spaces.

9. Ground Fault Interrupter:
   a. Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5-milliampere ground fault (UL 943, Class A sensitivity).
   b. Sensor with same rating as circuit breaker and a push-to-test button.

I. Manufacturers:

1. Bryant.
2. Cutler-Hammer.
3. General Electric.
4. Gould I-T-E.
5. Square D.
6. Westinghouse.

2.9 FUSE, 0 TO 600 VOLTS

A. Current-limiting, with 200,000 ampere rms interrupting rating.

B. Provide to fit mountings specified with switches and features to reject Class H fuses.

C. Motor and Transformer Circuits, 0- to 600-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-1, dual element, with time delay.
3. Manufacturers:
   a. Bussmann; Type LPS-RK.
   b. Littelfuse; Type LLS-RK.

D. Motor and Transformer Circuits, 0- to 250-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-1, dual element, with time delay.
3. Manufacturers:
   a. Bussmann; Type LPN-RK.
   b. Littelfuse; Type LLN-RK.

E. Feeder and Service Circuits, 0- to 600-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-1, dual element, with time delay.
3. Manufacturers:
   a. Bussmann; Type LPS-RK.
   b. Littelfuse; Type LLS-RK.

2.10 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCHES

A. Contact Rating: NEMA ICS 2, Type A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Lights: Transformer, push-to-test.

D. Pushbutton Color:

1. ON or START: Black.
2. OFF or STOP: Red.

E. Pushbuttons and selector switches lockable in the OFF position where indicated.

F. Legend Plate:

1. Material: Aluminum, with black letters.
2. Engraving: 11 character/spaces on one line, 14 character/spaces on each of two lines, as required, indicating specific function.
3. Letter Height: 7/64 inch.

G. Manufacturers:

1. Heavy-Duty, Oiltight Type:
   a. Allen Bradley; Type 800T.
   b. Square D; Type T.
   c. Cutler-Hammer; Type 10250T.
2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
   a. Allen Bradley; Type 800H.
   b. Square D; Type SK.
   c. Cutler-Hammer; Type E34.
   d. Crouse-Hinds; Type NCS.

2.11 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless otherwise shown.

B. Terminal Blocks: Provide separate connection point for each conductor entering or leaving box.

1. Spare Terminal Points: 25 percent.

C. Interior Finish: Paint with white enamel or lacquer.

2.12 TERMINAL BLOCK (0 TO 600 VOLTS)

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of all control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between the compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

1. Capable of wire connections without special preparation other than stripping.
2. Capable of jumper installation with no loss of terminal or rail space.
3. Individual, rail mounted.

I. Marking system allowing use of preprinted or field-marked tags.

J. Manufacturers:

1. Weidmuller.
2. Ideal.
3. Electrovert.
4. Thomas & Betts.

2.13 MAGNETIC CONTROL RELAY

A. NEMA ICS 2, Class A600 (600 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control with field convertible contacts.

B. Time Delay Relay Attachment:

1. Pneumatic type, timer adjustable from 5 to 200 seconds (minimum).
2. Field convertible from ON delay to OFF delay and vice versa.

C. Latching Attachment: Mechanical latch having unlatching coil and coil clearing contacts.

D. Manufacturers:

1. Cutler-Hammer; Type M-600.
2. General Electric; Type CR120B.

2.14 ELAPSED TIME METER

A. Drive: Synchronous motor.

B. Range: 0 to 99,999.9 hours, nonreset type.

C. Mounting: Semiflush, panel.

D. Manufacturers:

1. General Electric; Type 240, 2-1/2-inch Big Look.
2. Eagle Signal; Bulletin 705.

2.15 MAGNETIC LIGHTING CONTACTOR

A. NEMA ICS 2, UL 508.

B. Electrically operated by dual-acting, single coil mechanism.

C. Inherently interlocked and mechanically held in both OPEN and CLOSED position.

D. Main Contacts:

1. Power driven in both directions.
2. Double-break, continuous-duty, rated 30 amperes, 600 volts, withstand rating of 14,000 amps rms symmetrical at 480 volts.
3. Marked for electric discharge lamps, tungsten, and general-purpose loads.
4. Position not dependent on gravity, hooks, latches, or semi-permanent magnets.
5. Capable of operating in any position.
6. Visual indication for each contact.

E. Auxiliary contact relay for two-wire control.

F. One normally open and one normally closed auxiliary contacts rated 10 amperes at 480-volt.

G. Provision for remote pilot lamp with use of auxiliary contacts.

H. Clamp type, self-rising terminal plates for solderless connections.

I. Enclosure: NEMA 250, Type 12, Dust-Tight, Drip-Tight, Industrial Use, unless otherwise shown.

J. Manufacturers:

1. ASCO.
2. Westinghouse; Class A202.
3. General Electric; Class 360.

2.16 THERMOSTAT

A. Rating: At continuous 60-Hz of 8 amps at 240 volts and 16 amps at 120 volts, and continuous 60-Hz inductive rating of 4 amps at 240 volts and 8 amps at 120 volts.

B. Line voltage, single-stage, snap-action control contacts, with indicating thermometer in the cover.

C. Cooling and Ventilating Adjustment Range: 66 to 94 degrees F, contacts closing on temperature rise, and locked rotor current rating of 24 amps at 240 volts and 48 amps at 120 volts.

D. Manufacturer: Honeywell; Type T6051A.

2.17 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. UL 1561, NEMA ST 20, unless otherwise indicated.

B. Self-cooled, two-winding.

C. Insulation Class and Temperature Rise: Manufacturer's standard.

D. Core and Coil:

1. Encapsulated for single-phase units 1/2 to 25 kVA and for three-phase units 3 to 15 kVA.
2. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for three-phase units 30 kVA and above.

E. Enclosure:

1. Single-Phase, 3 to 25 kVA: NEMA 250, Type 3R, nonventilated.
2. Three-Phase, 3 to 15 kVA: NEMA 250, Type 3R, nonventilated.
3. Outdoor Transformers: NEMA 250, Type 3R.

F. Voltage Taps: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

G. Maximum Sound Level: NEMA ST 20:

1. 40 decibels for 0 to 9 kVA.
2. 45 decibels for 10 to 50 kVA.

H. Vibration Isolators:

1. Rated for transformer's weight.
2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
3. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.

I. Manufacturers:

1. General Electric.
2. Square D.
3. Westinghouse.

2.18 LOW VOLTAGE, SECONDARY SURGE PROTECTIVE EQUIPMENT

A. NEMA LA 1, ANSI C62.11.

B. Surge Capacitor:

1. Impregnated with non-PCB, biodegradable dielectric fluid.
2. Integral discharge resistor which will drain residual voltage to 50 volts crest in less than 1 minute after disconnection from circuit.

C. Arrestor: High strength metal oxide valve elements enclosed in high strength, corrosion resistant, molded resin housing.

D. Equip capacitor and arrestor with mounting nipple, flat washer, and nut suitable for knockout or bracket mounting.

2.19 SUPPORT AND FRAMING CHANNELS

A. Material: Rolled, mild strip steel, 12-gauge, ASTM A570, Grade 33.

B. Finish:

1. Dry Areas: Hot-dip galvanize.
2. Corrosive and Wet Areas: ASTM A167, Type 304 stainless steel or fiber-reinforced epoxy.

C. Inserts: Continuous.

D. Beam Clamps: Zinc/cadmium plated mild steel.

E. Manufacturers:

1. B-Line.
2. Unistrut.

2.20 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color: White, engraved to a black core.

D. Engraving:

1. Pushbuttons/Selector Switches: Name of drive controlled on one, two, or three lines, as required.
2. Panelboards: Panelboard designation, service voltage, and phases.

E. Letter Height:

1. Pushbuttons/Selector Switches: 1/8 inch.

2. Panelboards: 1/4 inch.

2.21 INSTRUMENTS AND CONTROL COMPONENTS

A. Refer to supplement at the end of this section.

PART 3 EXECUTION

3.1 GENERAL

A. Install equipment in accordance with NECA 5055.

3.2 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in the wiring or raceway system, sized to meet NFPA 70 requirements.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
   a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch sheet steel device box.

C. Locations:

1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by RESIDENT ENGINEER.
3. Light Switch: Install on lock side of doors.
4. Light Fixture: Install in symmetrical pattern according to room layout unless otherwise shown.

D. Mounting Height:

1. General:
   a. Measured to centerline of box.
   b. Where specified heights do not suit building construction or finish, mount as directed by RESIDENT ENGINEER.
2. Light Switch: 48 inches above floor.
3. Thermostat: 54 inches above floor.
4. Telephone Outlet: 6 inches above counter tops or 15 inches above floor.
5. Wall Mounted Telephone Outlet: 52 inches above floor.
6. Convenience Receptacle:
   a. General Interior Areas: 15 inches above floor.
   b. Industrial Areas, Workshops: 48 inches above floor.
   c. Outdoor, All Areas: 24 inches above finished grade.

E. Install plumb and level.

F. Flush Mounted:

1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
3. Holes in surrounding surface shall be no larger than required to receive box.

G. Support boxes independently of conduit by attachment to building structure or structural member.

H. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws threaded into steelwork.

I. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

J. Provide plaster rings where necessary.

K. Boxes embedded in concrete or masonry shall be wrapped with 20 mil pipe wrap.

L. Install galvanized mounting hardware in industrial areas.

M. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.

N. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

O. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.

P. Box Type (Steel Raceway System):

1. Exterior Locations: Cast metal.
2. Interior Dry Locations:
   a. Exposed Rigid Conduit or IMC: Sheet steel.
   b. Exposed EMT: Sheet steel.
   c. Concealed Raceways: Sheet steel.
   d. Lighting Circuits, Ceiling: Sheet steel.
3. Cast-In-Place Concrete Slabs: Sheet steel.

Q. Box Type (Nonmetallic Raceway System):

1. Corrosive Locations: Nonmetallic.
2. Concrete Encased Raceways: Cast metal.

3.3 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 100 feet or after the equivalent of three right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Installed boxes shall be accessible.

F. Do not install on finished surfaces.

G. Install plumb and level.

H. Support boxes independently of conduit by attachment to building structure or structural member.

I. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork.

J. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. At or Below Grade:

1. Install boxes for below grade conduits flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Obtain OWNER's written acceptance prior to installation in paved areas, roadways, or walkways.
4. Use boxes and covers suitable to support anticipated weights.

M. Flush Mounted:

1. Install with concealed conduit.
2. Holes in surrounding surface shall be no larger than required to receive box.
3. Make edges of boxes flush with final surface.

N. Mounting Hardware:

1. Noncorrosive Areas: Galvanized.
2. Corrosive Areas: PVC-coated steel.

O. Location/Type:

1. Finished, Indoor, Dry: NEMA 250, Type 1.
2. Unfinished, Indoor, Dry: NEMA 250, Type 12.
3. Unfinished Indoor and Outdoor, Wet: NEMA 250, Type 4.
4. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
5. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.
6. Underground Conduit: Concrete.

3.4 TELEPHONE OUTLET

A. Provide empty outlet boxes and cover plates meeting requirements of telephone company.

3.5 WIRING DEVICES

A. Switches:

1. Mounting Height: See Article OUTLET AND DEVICE BOXES.
2. Install with switch operation in vertical position.
3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:

1. Install with grounding slot down except where horizontal mounting is shown, in which case install with neutral slot up.
2. Ground receptacles to boxes with grounding wire only.
3. Weatherproof Receptacles:
   a. Install in cast metal box.
   b. Install such that hinge for protective cover is above receptacle opening.
4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for "downstream" conventional receptacles. Label "downstream" receptacles as GFI protected.
5. Special-Purpose Receptacles: Install in accordance with manufacturer's instructions.

3.6 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to the box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Types (Unless Otherwise Shown):

1. Exterior: Weatherproof.
2. Interior:
   a. Flush Mounted Boxes: Metal.
   b. Surface Mounted, Cast Metal Boxes: Cast metal.
   c. Surface Mounted, Sheet Steel Boxes: Metal.
   d. Surface Mounted, Nonmetallic Boxes: Metal.

3.7 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Heavy-Duty, Oiltight Type: Locations (Unless Otherwise Shown): Nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Heavy-Duty, Watertight, and Corrosion-Resistant Type:

1. Locations (Unless Otherwise Shown): Nonhazardous, outdoor, or normally wet areas.
2. Mounting: NEMA 250, Type 4X enclosure.

3.8 TERMINAL JUNCTION BOX

A. Install in accordance with Article JUNCTION AND PULL BOXES.

B. Label each block and terminal with permanently attached, nondestructible tag.

C. Do not install on finished outdoor surfaces.

D. Location:

1. Finished, Indoor, Dry: NEMA 250, Type 1.
2. Unfinished, Indoor, Dry: NEMA 250, Type 12.
3. Unfinished, Indoor and Outdoor, Wet: NEMA 250, Type 4.
4. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
5. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.

3.9 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. Install securely, plumb, in-line and square with walls.

B. Install top of cabinet 6 feet above floor unless otherwise shown.

C. Provide typewritten circuit directory for each panelboard.

3.10 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

B. Provide moistureproof, flexible conduit for electrical connections.

C. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

D. Provide wall brackets for single-phase units, 15 to 167-1/2 kVA, and three-phase units, 15 to 112 kVA.

3.11 SUPPORT AND FRAMING CHANNEL

A. Furnish zinc-rich primer; paint cut ends prior to installation.

B. Install where required for mounting and supporting electrical equipment and raceway systems.

3.12 MOTOR SURGE PROTECTION

A. Ground in accordance with NFPA 70.

B. Low Voltage: Ground terminals to equipment bus.

3.13 INSTRUMENTS AND CONTROL COMPONENTS

A. Install in accordance with manufacturer's printed instructions.

3.14 FIELD QUALITY CONTROL

A. Perform testing and calibration in accordance with manufacturer's recommendations and as necessary to complete manufacturer's Certificate of Proper Installation.

3.15 SUPPLEMENT

A. Supplement listed below, following "END OF SECTION," is part of this Specification.

1. Component Specifications.

END OF SECTION

COMPONENT SPECIFICATIONS

A. F4 Flow Element and Transmitter, Electromagnetic:

1. General:
   a. Tag Number: FE/FIT-3-1.
   b. Function: Measure, indicate, and transmit the flow of a process liquid in a full pipe.
   c. Type: Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
   d. Parts: Flow element, transmitter, interconnecting cables, mounting hardware, and calibrator.
2. Service:
   a. Stream Fluid: Lake water.
3. Performance:
   a. Flow Range: 100 cfs.
   b. Accuracy: Plus or minus 1 percent of rate for all flows resulting from pipe velocities of 1 to 33 feet per second.
   c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
4. Features:
   a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
   b. No obstructions to flow.
   c. Very low pressure loss.
5. Process Connection:
   a. Meter Size: 42-inches.
   b. Connection Type: 150-pound ANSI raised-face flanges or wafer style depending on meter size, unless otherwise noted.
   c. Flange Material: Carbon steel, unless otherwise note.d
6. Signal Interface:
   a. 4 to 20 mA dc for load impedance 0 to 800 ohms minimum for 24V dc supply.
7. Power: 120V ac, 60-Hz, unless otherwise noted.
8. Element:
   a. Meter Tube Material: 304 stainless steel, unless otherwise noted.
   b. Liner Material: Polyurethane, unless otherwise noted.
   c. Liner Protectors: Covers on each end to protect liner during shipment.
   d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
   e. Electrode Material: 316 stainless steel, unless otherwise noted.
   f. Enclosure: Suitable for accidental submergence.
   g. Grounding Ring/Electrode Material: 316 stainless steel, unless otherwise noted.
9. Transmitter:
   a. Display: Indicating and totalizing.
   b. Mounting: Wall.
   c. Enclosure: NEMA 4X.
   d. Zero and Span: Field adjustable.

e. Indicator: Digital 16-character display, with scale range as noted.
f. Totalizer: Digital 16-character display, with totalizer unit digit value as noted.

10. Cables:
    a. Types: As recommended by manufacturer.
    b. Lengths: As required to accommodate device locations.
11. Calibration System:
    a. Features:
        1) Field programmable electronics.
        2) Self-diagnostics with troubleshooting codes.
        3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
        4) Initial flow tube calibration and subsequent calibration checks.
    b. Equipment:
        1) Built-in electronics with each unit provided.
        2) Alternatively, one portable calibrator of each type required for the various electromagnetic flowmeters provided on the project.
12. Manufacturers:
    a. Sparling Instruments, Tigermags, Model FM655.
    b. Foxboro, Series 8000 or Series 2800 flow tube with Model 896 transmitter, as applicable;
    c. Fischer & Porter, miniMAG, COPA-X or MAG-X, as applicable;
    d. Rosemount, Model 8701 flow tube with Model 8712 transmitters.

B. L8 Level Switch, Float Type with Integral Switch:

1. General:
    a. Function: Actuate contact at preset liquid level.
    b. Type: Direct-acting float with an enclosed mercury switch and integral cable.
2. Service:
    a. Liquid: Water.
    b. Pressure: Atmospheric.
    c. Temperature: 0 to 50 degrees C.
3. Performance:
    a. Set Point: As shown.
    b. Differential: 1-inch maximum.
    c. Temperature: 0 to 120 degrees F (50 degrees C).
4. Features:
    a. Entire Assembly: Watertight and impact-resistant.
    b. Cable: Combination support and signal; length as noted or as necessary per mounting requirements.

c. Materials:
   1) Float: Chemical resistant polypropylene or other corrosion resistant material suitable for use in sewage and sludge applications.
   2) Cable: Type STO No. 18-2, neoprene or PVC jacket, rated 600V.
   3) Clamps: PVC or Neoprene.

d. Mounting: Pipe.
   1) Pipe: Corrosion-proof cable clamp for 1-inch pipe.

5. Signal Interface:
   a. Switch: SPST or DPST, arrangement as required per Drawings.
   b. Contact: Rated 5A continuous at 120V ac.

6. Manufacturers:
   a. Consolidated Electric Co., Model LS with mounting accessories.
   b. Anchor Scientific, Roto-Float, Type P and Type S, with mounting accessories.

END OF COMPONENTS

SECTION 16110
RACEWAYS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's Literature:
   a. Rigid galvanized steel conduit.
   b. Intermediate metal conduit.
   c. Electric metallic tubing.
   d. PVC Schedule 40 conduit.
   e. PVC tubing (Type EB) conduit.
   f. PVC-coated rigid galvanized steel conduit.
   g. Flexible metal, liquid-tight conduit.
   h. Conduit fittings.
2. Precast Pullboxes:
   a. Dimensional drawings and descriptive literature.
   b. Traffic loading calculations.
   c. Accessory information.
3. Conduit Layout:
   a. Plan and section type, showing arrangement and location of conduit and duct bank required for:
      1) Low and medium voltage feeder and branch circuits.
      2) Instrumentation and control systems.
      3) Communications systems.
      4) Empty conduit for future use.
   b. Reproducible mylar; scale not greater than 1 inch equals 20 feet.
4. Equipment and machinery proposed for bending metal conduit.
5. Method for bending PVC conduit less than 30 degrees.

1.2 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS):

1. Meet requirements of ANSI C80.1 and UL6.
2. Material: Hot-dip galvanized, with chromated protective layer.

B. Intermediate Metal Conduit (IMC):

1. Meet requirements of ANSI C80.6 and UL 1242.

2. Material: Hot-dip galvanized, with chromated and lacquered protective layer.

C. Electric Metallic Tubing (EMT):

1. Meet requirements of ANSI C80.3 and UL 797.
2. Material: Hot-dip galvanized, with chromated and lacquered protective layer.

D. PVC Schedule 40 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

E. PVC Tubing (Type EB):

1. Meet requirements of NEMA TC 6 and UL 651A.
2. UL listed for reinforced concrete encasement and 90 degrees C insulated conductors.

F. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

2.2 FITTINGS

A. Rigid Galvanized Steel and Intermediate Metal Conduit:

1. General:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized. Set screw fittings not permitted.
2. Bushing:
   a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
   b. Manufacturers:
      1) Thomas & Betts.
      2) O.Z. Gedney.
3. Grounding Bushing:
   a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
   b. Manufacturers:
      1) Appleton.
      2) O.Z. Gedney.
4. Conduit Hub:
   a. Material: Malleable iron with insulated throat.
   b. Manufacturers:
      1) O.Z. Gedney.
      2) T & B.
5. Conduit Bodies:
   a. Material: Malleable iron, sized as required by NFPA 70.

b. Manufacturers (For Normal Conditions):
   1) Appleton.
   2) Crouse-Hinds.
   3) Killark.

6. Couplings: As supplied by conduit manufacturer.
7. Expansion Fitting Manufacturers:
   a. Appleton.
   b. Crouse-Hinds.
8. Cable Sealing Fittings:
   a. To form watertight nonslip cord or cable connection to conduit.
   b. For Conductors With OD of 1/2 Inch or Less: Neoprene bushing at connector entry.
   c. Manufacturers:
      1) Crouse-Hinds.
      2) Appleton.

B. Electric Metallic Tubing:

1. Meet requirements of UL 514B.
2. Type: Steel body and locknuts with steel or malleable iron compression nuts. Set screw and drive-on fittings not permitted.
3. Compression Ring: Stainless steel.
4. Coupling Manufacturers:
   a. Appleton.
   b. Crouse-Hinds.
5. Connector Manufacturers:
   a. Appleton.
   b. Crouse-Hinds.

C. PVC Conduit and Tubing:

1. Meet requirements of NEMA TC-3.
2. Type: PVC, slip-on.

D. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
2. Insulated throat and sealing O-rings.
3. Long design type extending outside of box or other device at least 2 inches.
4. Manufacturer: T & B

E. Watertight Entrance Seal Device:

1. New Construction:
   a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
   b. Manufacturer: O.Z. Gedney.
2. Cored-Hole Application:
   a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
   b. Manufacturer: O.Z. Gedney.

2.3 PRECAST PULLBOXES

A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

B. Loading: AASHTO Division 1, H-20 in accordance with ASTM C857.

C. Access: Provide cast concrete 6- or 12-inch risers and access hole adapters between top of pullbox and finished grade at required elevations.

D. Drainage:

1. Slope floors toward drain points, leaving no pockets or other nondraining areas.
2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe.

E. Raceway Entrances:

1. Provide on all four sides.
2. For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.
3. At entrances where raceways are to be installed by others, provide minimum 12-inch high by 24-inch wide knockout panels for future raceway installation.

F. Embedded Pulling Iron:

1. Material: 3/4-inch diameter stock, fastened to overall steel reinforcement before concrete is placed.
2. Location:
   a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
   b. Floor: Centered below pullbox cover.

G. Cable Racks:

1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
2. Wall Attachment:
   a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
   b. Insert Spacing: Maximum 3-foot on center entire inside perimeter of manhole.
   c. Arrange so that spare raceway ends are clear for future cable installation.

H. Pullbox Frames and Covers:

1. Material: Steel, hot-dipped galvanized.
2. Cover Type: Solid, bolt-on, hinged, torsion spring, nonskid design.
3. Cover Loading: H-20.

4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
   a. Above 600 Volts: ELECTRIC HV.
   b. 600 Volts and Below: ELECTRIC LV.
   c. TELEPHONE.

I. Hardware: Steel, hot-dip galvanized.

J. Furnish knockout for ground rod in each pullbox.

K. Manufacturers:

1. Brooks Products, Inc.
2. Penn-Cast Products, Inc.
3. Concrete Conduit Co.
4. Associated Concrete Products, Inc.
5. Utility Vault Co.
6. Pipe, Inc.

2.4 ACCESSORIES

A. Duct Bank Spacers:

1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturer: Underground Device, Inc.; Type WUNPEECE.

B. Identification Devices:

1. Raceway Tags:
   a. Material: Permanent, nonferrous metal.
   b. Shape: Round.
   c. Raceway Designation: Pressure stamped, embossed, or engraved.
   d. Tags relying on adhesives or taped-on markers not permitted.
2. Warning Tape:
   a. Material: Polyethylene, 4-mil gauge.
   b. Color: Red.
   c. Width: Minimum 3-inch.
   d. Designation: Warning on tape that electric circuit is located below tape.
   e. Manufacturers:
      1) Blackburn, Type RT.
      2) Griffolyn Co.
3. Buried Raceway Marker:
   a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
   b. Designation: Incise to depth of 3/32-inch, ELECTRIC CABLES, in letters 1/4-inch high.
   c. Minimum Dimension: 1/4-inch thick, 10 inches long, and 3/4-inch wide.

C. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
2. Manufacturer: Raychem; Type TWDB.

PART 3 EXECUTION

3.1 GENERAL

A. Conduit and tubing sizes shown are based on the use of copper conductors.

B. All installed Work shall comply with NECA 5055.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

G. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

H. Group raceways installed in same area.

I. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

J. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

K. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

L. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.

M. Install watertight fittings in outdoor, underground, or wet locations.

N. Paint threads, before assembly of fittings, of galvanized conduit or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

O. All metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

P. Do not install raceways in concrete equipment pads, foundations, or beams.

Q. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

R. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

3.2 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum cover 1-1/2 inches.

B. Provide support during placement of concrete to ensure raceways remain in position.

C. Floor Slabs:

1. Outside diameter of conduit not to exceed one-third of the slab thickness.
2. Separate conduit by minimum six times conduit outside diameter, except at crossings.

3.3 CONDUIT APPLICATION

A. Diameter: Minimum 3/4-inch.

B. Exterior, Exposed:

1. Rigid galvanized steel.
2. Intermediate metal.

C. Interior, Exposed:

1. Rigid galvanized steel.
2. Intermediate metal.
3. Electric metallic tubing for ceiling portion of lighting circuits.

D. Interior, Concealed (Not Embedded in Concrete):

1. Rigid galvanized steel.
2. Intermediate metal.

E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors:

1. Rigid galvanized steel.
2. Intermediate metal.
3. PVC Schedule 40.
4. Electric metallic tubing for lighting and receptacle circuits only.

F. Direct Earth Burial: PVC Schedule 40.

G. Concrete-Encased Raceways:

1. Rigid galvanized steel.
2. PVC Schedule 40.

H. Under Slabs-On-Grade:

1. Rigid galvanized steel.
2. PVC Schedule 40.

3.4 CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:

1. Conduit Size 4 Inches or Less: Flexible metal, liquid-tight conduit.
2. Conduit Size Over 4 Inches: Nonflexible.
3. Length: 18-inch minimum, 60-inch maximum, of sufficient length to allow movement or adjustment of equipment.

B. Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

3.5 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Fire-stop openings around penetrations to maintain fire-resistance rating.

D. Apply single layer of wraparound duct band to all metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

F. Entering Structures:

1. General: Seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
2. Concrete Roof or Membrane Waterproofed Wall or Floor:
   a. Provide a watertight seal.
   b. Without Concrete Encasement: Install watertight entrance seal device on each side.
   c. With Concrete Encasement: Install watertight entrance seal device on the accessible side.
   d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
   e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.

3. Heating, Ventilating, and Air Conditioning Equipment:
   a. Penetrate equipment in area established by manufacturer.
   b. Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
4. Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device.
5. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
   a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
   b. Fill space between raceway and sleeve with an expandable plastic compound, or an oakum and lead joint, on each side.
6. Pullboxes:
   a. Metallic Raceways: Provide insulated grounding bushings.
   b. Nonmetallic Raceways: Provide bell ends flush with wall.
   c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.6 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze.

C. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

   1. Wood: Wood screws.
   2. Hollow Masonry Units: Toggle bolts.
   3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
   4. Steelwork: Machine screws.

D. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.7 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:

1. Bends 30-Degree and Larger: Provide factory-made elbows.
2. 90-Degree Bends: Provide rigid steel elbows.
3. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.8 EXPANSION/DEFLECTION FITTINGS

A. Provide on all raceways at all structural expansion joints, and in long tangential runs.

B. Provide expansion/deflection joints for 50 degrees F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.9 PVC CONDUIT

A. Solvent Welding:

1. Provide manufacturer recommended solvent; apply to all joints.
2. Install such that joint is watertight.

B. Adapters:

1. PVC to Metallic Fittings: PVC terminal type.
2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

C. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.

3.10 TERMINATION AT ENCLOSURES

A. Utilize fittings that maintain the NEMA 250, Environmental Rating of the Enclosure.

B. Cast Metal Enclosure: Provide manufacturer's pre-molded insulating sleeve inside metallic conduit terminating in threaded hubs.

C. Sheet Metal Boxes, Cabinets, and Enclosures:

1. Rigid Galvanized Intermediate Conduit:
   a. Provide one lock nut each on inside and outside of enclosure.
   b. Install grounding bushing.

c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
d. Install insulated bushing on ends of conduit where grounding is not required.
e. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.

2. Electric Metallic Tubing: Provide gland compression, insulated connectors.
3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
4. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut.

D. Motor Control Center, Switchgear, and Free-Standing Enclosures: Terminate conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.

3.11 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Cover: Maintain minimum 2-foot cover above conduit, unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts.

D. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Spacers:

1. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Installation with Other Piping Systems:

1. Crossings: Maintain minimum 12-inch vertical separation.
2. Parallel Runs: Maintain minimum 12-inch separation.
3. Installation over valves or couplings not permitted.

I. Metallic Raceway Coating: At couplings and joints, apply wraparound duct band with one-half tape width overlap to obtain two complete layers.

J. Backfill:

1. As specified in Section 02225, TRENCH BACKFILL.
2. Do not backfill until inspected by RESIDENT ENGINEER.

3.12 PULLBOXES

A. Excavate, shore, brace, backfill, and final grade in accordance with Section 02205, EXCAVATION, and Section 02225, TRENCH BACKFILL.

B. Do not install until final raceway grading has been determined.

C. Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.

D. Grounding: As specified in Section 16450, GROUNDING.

E. Identification: Field stamp covers with manhole or pullbox number as shown. Stamped numbers to be 1-inch minimum height.

3.13 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Article IDENTIFICATION DEVICES, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.14 IDENTIFICATION DEVICES

A. Raceway Tags:

1. Identify origin and destination.
2. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed Raceway, whether in ceiling space or surface mounted.
3. Provide nylon strap for attachment.

B. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.

C. Buried Raceway Markers:

1. Install at grade to indicate direction of underground raceways.
2. Install at all bends and at intervals not exceeding 100 feet in straight runs.
3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.15 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

D. Touch up damage to coating on PVC-coated conduit with patching compound approved by manufacturer.

END OF SECTION

SECTION 16120
CONDUCTORS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Wire and cable descriptive product information.
2. Wire and cable accessories descriptive product information.
3. Cable fault detection system descriptive product information.

B. Quality Control Submittals: Certified Factory Test Report for conductors 600 volts and below.

1.2 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 3, WC 5, and WC 7.

B. Conductor Type:

1. 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Solid copper.
2. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Solid copper.
3. All Other Circuits: Stranded copper.

C. Insulation: THWN/THHN.

D. Flexible Cords and Cables:

1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 8.

2.2 600-VOLT RATED CABLE

A. General:

1. Type: TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu/hr, and NFPA 70, Article 340, or UL 13 Listed Power Limited Circuit Cable meeting requirements of NFPA 70, Article 725.

2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Type 3–No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.

1. Outer Jacket: 45-mil nominal thickness.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
3. Dimension: 0.31-inch nominal OD.
4. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
   b. 20 AWG, seven-strand tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nominal nylon.
   e. Color Code: Pair conductors black and red.
5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.

2.3 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.4 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arc and Fireproofing:
   a. 30-mil, elastomer
   b. Manufacturers and Products:
      1) Scotch; Brand 77, with Scotch Brand 69 glass cloth tapebinder.
      2) Plymount; Plyarc 30, with Plymount Plyglas glass cloth tapebinder.

B. Identification Devices:

1. Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.
2. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
3. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO.
2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO.

D. Cable Lugs:

1. In accordance with NEMA CC 1.
2. Rated 600 volts of same material as conductor metal.
3. Insulated, Locking-Fork, Compression Lugs:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) ILSCO; ILSCONS.
4. Uninsulated Crimp Connectors and Terminators:
   a. Manufacturers and Products:
      1) Square D; Versitide.
      2) Thomas & Betts; Color-Keyed.
      3) ILSCO.
5. Uninsulated, Bolted, Two-Way Connectors and Terminators:
   a. Manufacturers and Products:
      1) Thomas & Betts; Locktite.
      2) Burndy; Quiklug.
      3) ILSCO.

E. Cable Ties: Nylon, adjustable, self-locking, and reusable.

1. Manufacturer and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation: Thermally stabilized, crosslinked polyolefin with hotmelt adhesive internal coating.

1. Manufacturer and Product: Raychem; FCSM and WCSM.

2.5 PULLING COMPOUND

A. Nontoxic, noncorrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

D. Manufacturers and Products:

1. Ideal Co.; Yellow 77.
2. Polywater, Inc.
3. Cable Grip Co.

2.6 WARNING TAPE

A. As specified in Section 16110, RACEWAYS.

2.7 SOURCE QUALITY CONTROL

A. Conductors 600-Volts and Below: Test in accordance with UL 44 and 854 Standards.

PART 3 EXECUTION

3.1 GENERAL

A. Conductor installation to be in accordance with NECA 5055.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.

E. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

F. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

H. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4-inch smaller than raceway inside diameter.

3.2 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.
2. No. 8 AWG and Smaller: Provide colored conductors.
3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Brown Orange Yellow
NOTE: Phase A, B, C implies direction of positive phase rotation.		

4. Tracer: Outer covering of white with an identifiable colored strip other than green in accordance with NFPA 70.

3.3 CIRCUIT IDENTIFICATION

A. Circuits Appearing in Circuit Schedules: Identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:

1. Assign circuit name based on device or equipment at load end of circuit.

2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.
3. Identify termination point of opposite end of wire.

C. Method:

1. Conductors No. 3 AWG and Smaller: Identify with sleeves.
2. Cables, and Conductors No. 2 AWG and Larger:
   a. Identify with marker plates.
   b. Attach marker plates with nylon tie cord.
3. Taped-on markers or tags relying on adhesives not permitted.

3.4 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors No. 6 AWG and larger unless specifically indicated or approved by RESIDENT ENGINEER.

C. Connections and Terminations:

1. Install wire nuts only on solid conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 6 AWG and smaller.
3. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.
4. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.
5. Install uninsulated bolted, two-way connectors for motor circuit conductors No. 12 and larger.
6. Tape insulate all uninsulated connections.
7. Place no more than one conductor in any single-barrel pressure connection.
8. Install crimp connectors with tools approved by connector manufacturer.
9. Install terminals and connectors acceptable for type of material used.
10. Compression Lugs:
    a. Attach with a tool specifically designed for purpose.
    b. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
    c. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:

1. Indoors: Use general purpose, flame retardant tape.
2. Outdoors: Use waterproof, heat-shrink type insulation.

F. Cap spare conductors and conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:

1. Remove surplus wire, bridle and secure.
2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
4. Cable Protection:
   a. Maintain integrity of shielding of instrumentation cables.
   b. Ensure grounds do not occur because of damage to jacket over the shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.5 CONDUCTOR ARC AND FIREPROOFING

A. Install arc and fireproofing tape on 600-volt single conductors and cables except those rated Type TC at splices in manholes, handholes, vaults, cable trays, and other indicated locations.

B. Wrap conductors of same circuit entering from separate conduit together as a single cable.

C. Follow tape manufacturer's installation instructions.

3.6 FIELD QUALITY CONTROL

A. In accordance Section 16950, ELECTRICAL TESTING.

END OF SECTION

SECTION 16450
GROUNDING

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Product Data:
   a. Exothermic weld connectors.
   b. Mechanical connectors.
   c. Compression connectors.

1.2 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 GROUND ROD

A. Material: Copper or copper-clad steel.

B. Diameter: Minimum 5/8-inch.

C. Length: 10 feet.

2.2 GROUND CONDUCTORS

A. As specified in Section 16120, CONDUCTORS.

2.3 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Utilize low-smoke, low-emission process.
3. Manufacturers:
   a. Erico Products, Inc.; Cadweld and Cadweld Exolon.
   b. Thermoweld.

B. Compression Type:

1. Compress-deforming type; wrought copper extrusion material.
2. Single indentation for conductors 6 AWG and smaller.
3. Double indentation with extended barrel for conductors 4 AWG and larger.
4. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.

5. Manufacturers:
   a. Burndy Corp.
   b. Thomas and Betts Co.
   c. Ilso Corp.

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

1. Manufacturers:
   a. Burndy Corp.
   b. Thomas and Betts Co.

2.4 GROUNDING WELLS

A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

B. Manufacturers:

1. Christy Co.; No. G5.
2. Lightning and Grounding Systems, Inc.; I-R Series.

PART 3 EXECUTION

3.1 GENERAL

A. Grounding shall be in compliance with NFPA 70 and ANSI C2.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed non-current-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

E. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

F. Shielded Control Cables:

1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
3. Do not ground control cable shield at more than one point.

3.2 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.3 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and Above: Tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.4 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

3.5 GROUNDING WELLS

A. Install inside buildings, asphalt, and paved areas.

B. Install riser ring and cover flush with surface.

C. Place 6 inches crushed rock in bottom of each well.

3.6 CONNECTIONS

A. General:

1. Abovegrade Connections: Use either exothermic weld, mechanical, or compression-type connectors; or brazing.
2. Belowgrade Connections: Install exothermic weld or compression type connectors.
3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
4. Notify RESIDENT ENGINEER prior to backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.
2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:

1. Install in accordance with connector manufacturer's recommendations.
2. Install connectors of proper size for grounding conductors and ground rods specified.
3. Install using connector manufacturer's compression tool having proper sized dies.

D. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.7 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.8 PULLBOX GROUNDING

A. Install one ground rod inside each.

B. Ground Rod Floor Protrusion: 4 to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all noncurrent-carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 6 AWG copper conductor.

3.9 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.

B. Bond neutrals of pad-mounted transformers to four locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.10 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

3.11 FIELD QUALITY CONTROL

A. As specified in Section 16950, ELECTRICAL TESTING.

END OF SECTION

SECTION 16480
LOW VOLTAGE MOTOR CONTROL

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Itemized bill of material.
2. Descriptive information.
3. Dimensional drawings.
4. Conduit entrance locations.
5. Bus data.
6. Protective Devices: Copies of time-current characteristics.
7. Operational description.
8. Anchoring instructions and details.
9. Typed tabulation:
   a. Motor name; tag (equipment) numbers as shown on Drawings.
   b. Motor horsepower.
   c. Nameplate full load current.
   d. Measured load current and voltage.
   e. Heater catalog number.
   f. Protective device trip settings.
10. Attach above typed, tabulated data to a copy of starter manufacturer's overload heater selection tables for the starters provided.
11. Control Diagrams:
    a. NEMA ICS 2, Section 322.08 Type IS.
    b. Wiring Type B.
    c. In addition to standard NEMA control diagrams, provide the following:
       1) Remote control devices.
       2) Remote indication and/or pilot lights.
       3) Interconnections and interlocking circuits between starter and remote equipment.
       4) Remote sensors.
       5) Tag numbers associated with all control devices and equipment.
12. One-line diagrams.
13. Schematic (elementary) diagrams.
14. Outline diagrams.
15. Interconnection diagrams.

B. Quality Control Submittals:

1. Manufacturer's installation instructions.
2. Operation and Maintenance Manual.
3. Factory test reports, certified.

1.2 UL COMPLIANCE

A. Products manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL Listing Mark.

1.3 PACKING AND SHIPPING

A. Shipping Splits: Established by CONTRACTOR to facilitate ingress of equipment to final installation location within the building.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Allen Bradley.

B. Westinghouse.

C. Cutler-Hammer.

D. Square D.

2.2 MOTOR CONTROL

A. General:

1. Like Items of Equipment: End product of one manufacturer.
2. Make adjustments as necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.
3. Controllers: NEMA ICS 2, Class A.
4. Thermal Overload Protection:
   a. Inverse-time-limit characteristic.
   b. Heater: Directly heated melting alloy, ratchet principle type element.
   c. Relay Trip: Standard, Class 20.
   d. Manual reset.
   e. Provide in each ungrounded phase.
   f. Mount within starter unit.
5. Control Transformer:
   a. Two winding, 120-volt secondary, primary voltage to suit.
   b. Two current-limiting fuses for primary circuit.
   c. One fuse in secondary circuit.
   d. Mount within starter unit.
6. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
7. Lifting lugs on all equipment and devices weighing over 100 pounds.
8. Anchor Bolts: Galvanized, sized by equipment manufacturer, and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

9. Operating Conditions:
   a. Ambient Temperature: Maximum 50 degrees C.
   b. Equipment to be fully rated without any derating for operating conditions listed above.
10. Enclosures: In accordance with NEMA 250 and ANSI C57.12.28.
11. Equipment Finish:
   a. Electrocoating process applied over a rust-inhibiting phosphated base coating.
   b. Exterior Color: Manufacturer's standard.

B. Manually Operated Starter, Fractional Horsepower:

1. Rating: 16 amperes continuous at 277 volts maximum.
2. Single-phase, nonreversing, full voltage with overload protection.
3. Toggle operated.
4. Enclosure: As shown.
5. Handle guard/lock-off attachment.

2.3 MOTOR CONTROL CENTERS

A. General:

1. In accordance with NEMA ICS 2 and UL 845.
2. Voltage Rating: As shown.
3. Short Circuit Rating: 65,000 amperes rms symmetrical for entire motor control center as a complete assembly.
4. All controllers, feeder and branch circuit breakers, wire connections, and other devices to be front mounted and accessible unless otherwise noted.
5. NEMA ICS 2, Section 322.08.
   a. Class: I.
   b. Type: B.

B. Enclosure:

1. Type: NEMA 250 Type 1, gasketed.
2. Vertical Section Dimensions: 90 inches high, 20 inches wide, 20 inches deep.
3. Construction:
   a. Sheet steel reinforced with channel or angle irons.
   b. Butt sections flush, end-to-end against similar section without bolts, nuts, or cover plates causing interference.
   c. Removable top cover plates.
   d. Removable plates on end panels for future bus extension.
4. Section Mounting: Removable formed-steel channel sills and lifting angles to meet specified seismic requirements.
5. Horizontal Wiring Compartments: Accessible from front, full width, top and bottom.
6. Vertical Wiring Compartment: Full height, isolated from unit starters with separate door.
7. Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, or other unit capable of being wired from front without unit removal.

8. Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.
9. Door Interlocking: Interlock starter and feeder doors mechanically so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access at any time.
10. External disconnect handles, padlockable in OFF position.
11. Cable Entrance: Main leads enter from bottom; control and feeder circuits enter from bottom.

C. Bus:

1. Horizontal Power Bus:
   a. Three-phase tin-plated, aluminum, entire width of control center, rated as indicated.
   b. Construct to allow future extension of additional sections.
   c. Pressure type solderless lugs for each incoming line cable.
   d. Isolated from top horizontal wireway.
   e. Provide Belleville washers on bus connection bolts.
2. Vertical Power Bus:
   a. Three-phase tin-plated, aluminum, full height of section, rated 600 amperes.
   b. Sandwich type bus insulation providing deadfront construction with starter units removed except for bus stab openings.
   c. Insulated and isolated barrier complete with shutters.
   d. Provide Belleville washers on bus connection bolts.
3. Neutral Bus: None.
4. Ground Bus:
   a. Copper, 33 percent minimum of phase bus ampacity, entire width of control center.
   b. Provide Belleville washers on bus connection bolts.
5. Bus Bracing: 65,000 amperes rms symmetrical.

D. Motor Controller Unit:

1. Provide indicated individual components and control devices including pushbuttons, selector switches, indicating lights, control relays, time delay relays, and elapsed time meters as specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.
2. Construction:
   a. Drawout combination type with stab connections for starters NEMA ICS, Size 4 and smaller.
   b. Bolt-on combination type with cable connection to riser for starters NEMA ICS, Size 5 and larger.
   c. Readily interchangeable with starters of similar size.
   d. Pull-apart unit control wiring terminal boards on drawout units.
3. Starters:
   a. NEMA ICS 2, Section 322.08 standard rating, except none smaller than NEMA ICS, Size 1.
   b. Rating: Hp rated at 600 volt, UL labeled for 22,000 amperes with overload protection.
   c. Three-phase, nonreversing.
   d. Disconnect Type: Motor circuit protector.

e. Combination Full Voltage, Magnetic Starter:
   1) Control: As shown.
f. Combination Reduced Voltage, Magnetic Starter:
   1) Control: As shown.
g. Padlockable operating handle when de-energized.
h. Unit door interlocked to prevent opening when disconnect is in closed position.
i. Mechanical interlocked to prevent placing disconnect in ON position when unit door is open.
j. Minimum Dimensions: 12 inches high by full section width, less vertical wireway.

4. Disconnecting Device:
   a. In each starter, control circuit disconnect to de-energize circuits in unit which are not de-energized by starter power disconnect device.
   b. Padlockable in OPEN position.
5. Circuit Breaker:
   a. Meeting the requirements of NEMA AB1 and UL 489.
   b. Molded case with manufacturer's recommended trip setting for maximum motor protection.
   c. Thermal-magnetic trip or magnetic trip only as shown.
   d. Tripping indicated by operating-handle position.
   e. Interrupting capacity required for connection to system with short circuit capacity indicated.
6. Fused Switch:
   a. Heavy-duty, motor rated, load-break, quick-make, quick-break type meeting the requirements of UL 98 and NEMA KS 1.
   b. Current-limiting fuses, with rejection clips.
7. Motor Overload Protection:
   a. Temperature compensated, three-pole relay with directly heated melting alloy, rachet principle type elements.
   b. Manual-reset overload relays.
8. Motor Thermal Protector Interface: Manual-reset interposing relay for connection to motor-mounted thermal protector system.
9. Ground Fault Protection: Where indicated and as specified in paragraph Feeder Units and Main Protective Device, except provide instantaneous operation device.
10. Capacitor Connection: Terminals to allow easy connection of power factor correction capacitors on source side of starter overload relays on starters where capacitor connection is shown.

E. Control Unit:

1. Disconnecting Device: Capable of de-energizing external source control circuits in unit.
2. Control Devices: As indicated and as specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.
3. Control Wiring:
   a. Minimum wire size 14 AWG copper.
   b. Permanent sleeve type markers with wire numbers applied to each end of wires.

c. Terminate wires using insulated locking fork or ring type crimp terminals.
d. Terminate current transformer leads on shorting type terminal blocks.

F. Incoming Line Terminal:

1. Construction: As specified in paragraph Motor Controller Unit.
2. Incoming Service Feeder: Cable entering section at bottom.
3. Maximum short-circuit rating of 65,000 amperes.
4. Mechanical type CU-/AL lugs for 75 degrees C cable.

G. Feeder Unit Protective Device:

1. Construction: As specified in paragraph Motor Controller Unit.
2. Incoming Service Feeder: Cable entering section at bottom.
3. Molded Case Circuit Breaker:
   a. In accordance with NEMA AB1 and UL 489.
   b. Feeder protective device.
   c. Thermal-magnetic trip and interrupting capacity required for connection to system with short circuit capacity indicated.
   d. Indicate tripping by operating-handle position.
   e. Suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

H. Instruments: Provide a solid-state incoming line metering module with a 1 percent accuracy for all measurements. Unit shall display 3-phase amps, phase-to-phase voltage, phase-to-neutral voltage, megawatts, megavars, power factor, frequency, and megawatt demand. All metered values shall be displayed on an LED readout.

I. Pushbutton, Indicating Light, and Selector Switches: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

J. Elapsed Time Meters: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

K. Time Delay Relays: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

L. Control Relays: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

M. Reset Timers: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

N. Nameplates:

1. Laminated plastic; white, engraved to black core.
2. Provide for each motor control center and each unit.
3. Engrave with inscription shown on single-line diagram.
4. Provide blank nameplates on spaces for future units.
5. Attach with stainless steel panhead screws on face of control center.

O. Factory Testing: NEMA ICS 1, Section 109.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with NEMA ICS 2.3, Submittal Drawings, and Manufacturer's Instructions and Recommendations.

B. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.

C. Install equipment plumb and in longitudinal alignment with pad or wall.

D. Coordinate terminal connections with installation of secondary feeders.

E. Grout mounting channels into floor or mounting pads.

F. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.

3.2 CIRCUIT BREAKERS

A. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.

B. Adjust to approximately 11 times motor rated current.

C. Determine motor rated current from motor nameplate following installation.

3.3 OVERLOAD RELAY

A. Select and install overload relay heaters after the actual nameplate full-load current rating of motor has been determined.

3.4 MOTOR DATA

A. Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:

1. Motor served by tag number and equipment name.
2. Nameplate horsepower.
3. Motor code letter.
4. Full load amperes.
5. Service factor.
6. Installed overload relay heater catalog number.

3.5 FIELD QUALITY CONTROL

A. In accordance with Section 16950, ELECTRICAL TESTING.

3.6 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative in accordance with Section 01640, MANUFACTURERS' SERVICES, for the following services at jobsite or classroom as designated by OWNER, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance, and inspection of installation.
2. 2 person-days for functional and performance testing.

END OF SECTION

SECTION 16485
ADJUSTABLE FREQUENCY DRIVE SYSTEMS

PART 1 GENERAL

1.1 DEFINITIONS

A. Terms that may be used in this section:

1. AFD: Adjustable frequency drive.
2. MPR: Motor protection relay.
3. MTBF: Mean time between failure
4. PWM: Pulse width modulation.
5. ROM: Read only memory.
6. RTD: Resistance temperature detector.
7. Rated Load: Load specified for the equipment.
8. Rated Speed: Nominal rated (100 percent) speed specified for the equipment.
9. TDD: Total demand distortion.
10. THD: Total harmonic distortion.
11. TTL: Transistor transistor logic.

1.2 SYSTEM RESPONSIBILITY

A. The adjustable frequency drive system shall be provided by the submersible pump supplier to maintain continuity, compatibility, and single source responsibility of the entire recycle pump system.

B. Related Section: Section 11305, SUBMERSIBLE PUMPS.

1.3 SYSTEM DESCRIPTION

A. Performance Requirements:

1. AFD Efficiency: 97 percent minimum at rated speed and rated load.
2. Rated Continuous Operation Capacity: Not less than 1.15 times full load current rating of driven motor, as indicated on the motor nameplates, and suitable for continuous operation at any continuous overload which may be imposed on motor by driven pump operating over specified speed range.
3. Power Factor: 0.95 minimum for all operating speed and loads.
4. Basis for Harmonic Computations: Using Plant One-Line Diagram for current and voltage distortion computations, furnish line reactors, or higher pulse converter arrangements required to meet current/ voltage distortion limits.
5. Current Harmonic Distortion:
   a. Compute total current harmonic distortion at the line terminals of the AFD in accordance with IEEE Standard 519. Total demand distortion expressed as percent of maximum demand load current I_L shall not exceed 5.0 percent.

6. Voltage Harmonic Distortion: Compute voltage harmonic distortion at the line terminals of the AFD. THD shall not exceed 5 percent, and individual voltage harmonic distortion shall not exceed 3 percent.
7. Operation of one drive shall not adversely affect operation of other drives or equipment supplied from the same bus. Furnish series reactors, or other devices necessary for proper system operation.
8. All AFD components shall be housed within the drive enclosure and the enclosure shall not exceed the dimensions shown on the Drawings.

B. Design Requirements:

1. Design and provide drive system consisting of adjustable frequency controller, level control system, certain auxiliary items, and components necessary for complete operating system.
2. Drive System: Convert incoming three-phase, 60-Hz ac power to variable voltage, adjustable frequency output for adjustable speed operation of an ac induction squirrel-cage motor as specified in Section 11305, SUBMERSIBLE PUMPS, using the pulse-width-modulation (PWM) technique to produce the adjustable frequency output.
3. Furnish AFDs rated on basis of actual motor full load nameplate current rating.
4. System rated for continuous industrial duty and suitable for use with the motor specified in Section 11305, SUBMERSIBLE PUMPS.
5. Incoming Line Circuit Breaker: Provide positive means of disconnecting incoming power, overcurrent, and ground fault protection for the drive system.
6. Other equipment is being powered from same bus as adjustable frequency drives. Ensure proper operation of drives and other loads under normal and emergency conditions.
7. Incoming Line Reactor: Design to minimize harmonic distortion on the incoming power feeder; 2-1/2 percent impedence, minimum.
8. Output Reactor: Design to reduce electrical stress on the submersible pump motor; 2-1/2 percent impedence, minimum.

1.4 SUBMITTALS

A. Shop Drawings:

1. Overall drive system operating data, including efficiencies, input currents, and power factors, at driven equipment actual load and rated system input voltage, at 0, 40, 60, 80, 100, and 110 percent of rated speed.
2. Individual and total harmonic content (voltage and current) reflected in system source supply at driven equipment actual load at 70 and 100 percent of rated speed at AFD line terminals. System short-circuit available is 18,000 amp rms symmetrical for harmonic calculation purposes. Use TDD and THD factors as defined in IEEE Standard 519 to designate total harmonic content.
3. AFD output pulse maximum peak voltage, pulse rise time and pulse rate of rise, including any justification for proposed deviation from specified values. Include motor manufacturer's certification that motor insulation will withstand long-term overvoltages caused at

motor terminals due to specified output pulse data or any proposed deviation from this data.

4. Complete system rating, including all nameplate data, continuous operation load capability throughout speed range of 0 to 100 percent of rated speed.
5. Complete adjustable frequency controller rating coordinated with motor full load nameplate current rating; list any controller special features being supplied.
6. Controller and reactor (if applicable) dimensional drawings; information on size and location of space for incoming and outgoing conduit.
7. Maximum heat dissipation from enclosure.
8. Should separate enclosures and equipment be necessary, provide complete dimensional information including location of space for incoming and outgoing conduit, weight, maximum heat loss, and minimum current carrying capacity and recommended wire size for required interconnecting circuits. Provide proposed construction modifications necessary to accommodate additional enclosures and equipment.
9. Layout of controller face showing pushbuttons, switches, instruments, indicating lights, etc.
10. Complete system operating description.
11. Complete system schematic (elementary) wiring diagrams.
12. Complete system interconnection diagrams between controller, drive motor, and all related components or controls external to system, including wire numbers and terminal board point identification.
13. One-line diagram of system, including component ratings.
14. Description of diagnostic features being provided.
15. Descriptive literature for all control devices such as relays, timers, etc.
16. Itemized bill-of-materials listing all system components.

B. Quality Control Submittals:

1. Statement of Supplier qualifications.
2. Factory functional test reports.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Field test reports.
6. Manufacturer's Certification of Proper Installation.
7. Suggested spare parts list to maintain equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
8. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
9. Operation and maintenance manual.

1.5 QUALITY ASSURANCE

A. Supplier: Minimum 5 years' experience in furnishing similar size and type adjustable frequency, controlled speed, drive systems.

1.6 EXTRA MATERIALS

A. Furnish for the projects one complete power bridge and one spare printed circuit card for each modular, plug-in type card in controller.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Components and accessories specified in this section shall be products of:

1. Robicon
2. Allen-Bradley.
3. Cegelec Automation.
4. Reliance Electric.

2.2 SERVICE CONDITIONS

A. Ambient Operating Temperature: 32 to 120 degrees F.

B. Storage Temperature: Minus 40 to 158 degrees F.

C. Humidity: 0 to 95 percent relative (noncondensing).

D. Altitude: 1,200 feet.

2.3 ADJUSTABLE FREQUENCY DRIVES

A. Drive Units:

1. Incorporate a switching power supply operating from a dc bus, to produce a PWM output waveform simulating a sine wave and providing power loss ride through of 2 milliseconds at full load, full speed.
2. Employ a three-phase, 12-pulse or higher, full wave diode bridge rectifier providing a constant displacement power factor of 0.95 minimum at all operating speeds and loads.
3. Employ dc power discharge circuit so that after removal of input power dc link capacitor voltage level will decay below 50 volts dc within 1 minute after de-energizing following NEMA CP 1 and NFPA 79. Design dc link capacitor for a MTBF of 5 years.
4. Input Voltage: 480V ac, plus 10 percent, minus 5 percent.
5. Output Voltage: 0 to 480 volts, three-phase, 0 to 60-Hz, minimum.
6. Controller: Microprocessor-controlled PWM inverter to convert dc voltage to variable voltage, adjustable frequency three-phase ac output. The output voltage shall vary proportionally with the frequency to maintain a constant ratio of volts to hertz up to 60-Hz. Above 60-Hz, the voltage shall remain constant, with the drive operating in a constant horsepower output mode.
7. Maximum peak voltage of PWM AFD output pulse of 1,000 volts, with pulse rise time of not less than 2 microseconds, and a maximum rate of rise of 500 volts per microsecond. Maximum frequency of PWM AFD output pulse (carrier) frequency of 3,000-Hz. Should

proposed magnitudes of these characteristics be more stressful to motor insulation than specified values, furnish insulation systems on the motors suitable for the proposed values.

8. Control circuit disconnect shall de-energize circuits in units that are not de-energized by main power disconnect device.
9. 120 volts, single-phase, 60-Hz circuits for control power and operator controls from internal control power transformer.
10. Arrange component and circuit such that failure of any single component cannot cause cascading failure(s) of any other component(s).
11. Motor Audible Noise Level: When operating throughout speed range of PWM AFD, no more than 3 dBA above that designated in NEMA MG 1 for same motor operated at constant speed with a 60-Hz supply voltage.
12. Short-Time Overload Capacity: 110 percent of rated load in rms current for 1 minute following full load, full speed operation.
13. Equipment Short-Circuit Rating: Suitable for connection to system with maximum source three-phase, bolted fault, short-circuit available of 22,000 amps rms symmetrical at 480 volts.
14. Furnish drives with output current-limiting reactors and input line reactors mounted within equipment enclosure.
15. Diagnostics: Comprehensive for drive adjustment and troubleshooting:
    a. Memory battery backup; 100-hour minimum during a power loss.
    b. Status messages will not stop drive from running but will prevent it from starting.
    c. Fault Condition Messages and History: First fault protection function to be activated, ability to store six successive fault occurrences in order. Minimum faults numerically:
        1) Overcurrent (time and instantaneous).
        2) Overvoltage.
        3) Undervoltage (dc and ac).
        4) Overtemperature (drive, motor windings).
        5) Short-circuit/ground fault (motor and drive).
        6) Motor stalled.
        7) Semiconductor fault.
        8) Microprocessor fault.
        9) Single-phase voltage condition.
16. Drive Protection:
    a. Fast-acting, current limiting, semiconductor fuses.
    b. Overcurrent, instantaneous overcurrent trip.
    c. Dc undervoltage protection, 70 percent dropout.
    d. Dc overvoltage protection, 130 percent pickup.
    e. Overtemperature, drive, inverter, converter, and dc link components.
    f. Overtemperature, motor.
    g. Anti-single-phase protection.
    h. Reset overcurrent protection (manual or automatic reset).
    i. Active current limit/torque limit protection.
    j. Semiconductor fault protection.
    k. Short-circuit/ground fault protection.
    l. Microprocessor fault.

m. Surge protection for transient overvoltage (6,000 volts, 80 joule surge, tested per ANSI/IEEE C62.41).
n. Visual display of specific fault conditions.

17. Operational Features:
    a. Use manufacturer's standard unless otherwise indicated.
    b. Power loss ride through (0.1 second).
    c. Start on the fly.
    d. Electronic motor overload protection.
    e. Stall protection.
    f. Slip compensation.
    g. Automatic restart after power return (ability to enable/disable function).
    h. Critical frequency lockout (three selectable points minimum, by 1.5-Hz steps in 10-Hz bands, to prevent resonance of system).
    i. Drive maintenance system software for complete programming and diagnostics.
    j. Operate with no motor connected to output terminals.

B. Enclosure:

1. NEMA 250, Type 1, gasketed, freestanding, enclosure for mounting against wall, completely front accessible, and hinged doors. Properly sized to dissipate heat generated by controller within limits of specified operating conditions (including ambient temperature and ambient airflow). Enclosure not to exceed dimensions shown on Drawings.
2. Furnish drive complete with cable termination compartment door interlocked main circuit breaker, defeatable (lockable in the open position), emergency stop pushbutton, alphanumeric keypad and display, and operator's controls. Components and controls specified in Section 16050, BASIC MATERIALS AND METHODS.
3. Wire drive from below for power and control wiring.
4. Size forced-ventilation for periodic operation to cool each unit with maximum room ambient temperature of 95 degrees F. Furnish redundant fans such that if one fan fails remaining fans furnish adequate ventilation for the drive when operating at maximum capacity. Furnish filters on ventilation intakes.
5. Bundle stranded copper wiring neatly with nylon tie wraps or with continuous plastic spiral binding; label each terminal for permanent identification of leads; identify each wire at each end with imprinted mylar adhesive-back wire markers; incorporate in as-installed wiring diagrams for wire and terminal numbers shown; wiring across door hinges use 19-strand, NEMA WC-57 Class C stranding looped for proper twist rather than bending at hinge; wire connections internal to panels by crimp-on terminal types. For multiple enclosure systems, complete interconnection wiring with gasketed enclosure openings for wiring; multipoint plug receptacles for any control wiring crossing equipment shipping splits.
6. Selector switches, indicating lights, potentiometers, instruments, protective devices, major system components, etc., identified by means of mechanically attached, engraved, laminated nameplates.

C. Operator Controls and Indicators:

1. Controls: Mount drive local control on front door of enclosure and include control switch and membrane type keypad for the following operator functions:
   a. Start (when in local mode).
   b. Stop (when in local mode).
   c. Speed increase (when in local mode).
   d. Speed decrease (when in local mode).
   e. Parameter mode selection (recall programmed parameters).
   f. LOCAL/OFF/REMOTE control selection (in remote, accept remote RUN command digital input and speed increase/decrease via remote 4 to 20 mA analog signal).
   g. Fault reset, manual for all faults (except loss of ac voltage which is automatic upon return).
   h. Parameter lock (password or key switch lockout of changes to parameters).
   i. Start disable (key switch or programmed code).
2. Alphanumeric Display: During normal operation and routine test, the following parameters shall be available:
   a. Motor current (percent of drive rated current).
   b. Output frequency (Hertz).
   c. Output voltage.
   d. Running time.
   e. Local/remote indicator.
   f. Status of digital inputs and outputs.
   g. Analog input and output values.
   h. Output motor current per leg.
   i. All test points.
3. Adjustable Parameters: Set drive operating parameters and indicate in a numeric form. Potentiometers may not be used for parameter adjustment. Minimum setup parameters available:
   a. Frequency range, minimum, maximum.
   b. Adjustable acceleration/deceleration rate.
   c. Volts per Hertz (field weakening point).
   d. Active current limit/torque limit, 0 to 140 percent of drive rating.
   e. Adjustable voltage boost (IR compensation).
   f. Preset speed (adjustable, preset operating point).
   g. Provision for adjustment of minimum and maximum pump speed to be furnished as function of 4 to 20 mA remote speed signal.

D. External Interfaces:

1. Digital Input: Accept a remote RUN command contact closure input.
2. Digital Output: Furnish discrete output dry contact closures rated 5 amps at 28 volts dc and 120 volts ac, minimum.
   a. DRIVE RUNNING.
   b. DRIVE FAULT (with common contact closure for all fault conditions).
   c. DRIVE IN REMOTE MODE.
3. Analog Input: When LOCAL/OFF/REMOTE switch is in REMOTE, control drive speed from a remote 4 to 20 mA dc signal. Make

provisions for adjustment of minimum and maximum motor speed which shall result from this signal. Factory set this adjustment to comply with operating speed range designated in driven equipment specifications. Frequency resolution shall be 0.1 percent of base speed. Provide a 4 to 20 mA dc signal isolator to receive the remote 4 to 20 mA dc signal.

4. Analog Output: Furnish one 4 to 20 mA dc signal, for actual output frequency, wired to terminal blocks for future use.

E. Accessories:

1. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
2. Lifting Lugs: Equipment weighing over 100 pounds.
3. Anchor Bolts: Galvanized, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 16050, BASIC MATERIALS AND METHODS.
4. Motor Protection Relay (MPR): For each drive include a motor protection relay as specified and provided under Section 11305, SUBMERSIBLE PUMPS. Communications protocol and signal compatibility shall be as required for motor protection relay.

2.4 LEVEL CONTROL SYSTEM

A. General:

1. Provide a level control system that monitors the recycle pump station wet well level, and controls the adjustable frequency drives to maintain that level within an adjustable control band. Utilize a stand alone PID loop controller to control AFD speed, and a small PLC to sequence the pumps on and off.
2. Components:
   a. Level Control Panel, LCP-3.
   b. Float-type level switches, LSL-3-1 and LSH-3-1, as specified in Section 16050, BASIC MATERIALS AND METHODS, Component Specifications Supplement, Component L8.
   c. Submersible level transmitter, LT-3-1, as specified in Section 16050, BASIC MATERIALS AND METHODS, Component Specifications Supplement, Component P5.

B. Level Control Panel, LCP-3:

1. Enclosure:
   a. NEMA 250, Type 12, wall mount, single door with three point latch.
   b. 16 gauge steel minimum.
   c. Doors: Rubber-gasketed with continuous stainless steel hinge.
   d. Steel back panel for component mounting.
   e. Dimensions: Sized to dissipate heat generated by equipment mounted in or on the panel, 36 inches high by 24 inches wide by 12 inches deep, maximum.

f. Finish: ANSI 61 grey polyester powder coat over phosphatized surfaces.
g. Interior Panels: White.
h. Enclosure shall be a standard manufactured item; Hoffman, H. F. Cox, or equal.

2. Operator Controls and Indications:
   a. Power ON indicting light.
   b. System TROUBLE alarm light.
   c. Four-position lead selector switch.
   d. Flush-mount PID loop controller.
   e. PLC system to provide control and sequencing logic.
3. External Interfaces:
   a. Digital inputs, dry contact closure inputs.
      1) FAIL inputs from each of four AFD's.
      2) ON inputs from each of four AFD's.
      3) Recycle pump station wet well HIGH and LOW level.
   b. Digital outputs, isolated contact closures rated 5A at 120V ac.
      1) RUN outputs to each of four AFD's.
      2) System TROUBLE.
   c. Analog Inputs: 4 to 20 mA dc level signal from LT-3-1.
   d. Analog Outputs: 4 to 20 mA dc speed outputs to each of four AFD's.
4. Power Requirements: LCP-3 will be supplied with 120V ac, 60 Hz power. Provide any additional transformers or power supplies necessary for proper operation.
5. Functional Requirements: Initial construction will install only two AFD's. Provide all components and software necessary to accommodate future addition of two more AFD's.
   a. Monitor the analog level signal from LT-3-1. Provide contact closure outputs to the AFD's based on adjustable level set points, See Table 1.
   b. Provide lead selection of up to four pumps, with lag pumps following in sequence (i.e., No. 3 selected lead, then No. 4 is lag, No. 1 is second lag, and No. 2 is third lag). Start and stop pumps based on level set points and according to Table 1.
   c. Provide proportional/integral control of wet well level. Process variable is wet well level, controlled variable is AFD speed. Level set point shall be adjustable; initially set at Elevation 1127.5.
   d. Monitor float type level switches LSL-3-1 and LSH-3-1. Actuate system trouble alarm if either high or low level condition exists. Shutdown all pumps on low level.
   e. Indicate and provide a discrete output for SYSTEM TROUBLE under any of the following conditions:
      1) PLC FAIL.
      2) Wet well level LOW or HIGH.
      3) AFD FAIL.
      4) AFD called, but not running after an adjustable time delay.

Table 1		
Set Point Elevation Increasing	**Reset Elevation Decreasing**	**Function**
1127.6	1125.0	Run Lead Pump
1128.2	1126.2	Run Lag Pump
1128.6	1126.6	Run Second Lag Pump
1129.0	1127.0	Run Third Lag Pump

6. Component Specifications:
   a. S6 Controller, Microprocessor:
      1) General:
         a) Function: Control process variable.
         b) Type: 1/4 DIN, microprocessor-based configurable PID controller.
      2) Features:
         a) Process Variable Range: As noted.
         b) Internal 24V dc loop power supply.
         c) Circuit Board: Coated-glass epoxy.
         d) Memory: Nonvolatile to retain configuration and parameters during power outage.
         e) Service Legend: Designated area on instrument face for engraved laminated plastic service legend.
         f) Indicators on Front Panel:
            (1) Digital: Three minimum; used for PV, SP, and output in engineering units.
      3) Controller Features:
         a) Bumpless Transfer: Bumpless and procedureless transfer between various switchable modes, including MANUAL and AUTO. Bumpless means that the output of the controller does not change instantaneously when the operating mode is changed; procedureless means that balancing is not required by the operator to achieve bumpless transfer.
         b) Control Action: P, PI, or PID selectable.
            (1) Proportional: 3 to 500 percent proportional band.
            (2) Integral: 0.02 to 50 repeats per minute with anti-windup reset, and off.
            (3) Derivative: 0 to 8 minutes and off.
            (4) Action: Switch selectable direct or reverse control.
         c) Self-Tuning: When noted.
         d) Controller Output:
            (1) MANUAL: Adjusted by INCREASE/DECREASE pushbuttons.

(2) AUTO: Internally derived from the process variable and the set point according to control action noted.

4) Signal Interface:
   a) Controller Output: 4 to 20 mA dc for output impedance 0 to 600 ohms minimum for 24V dc supply without load adjustments.
   b) PV Input: 4 to 20 mA dc, external resistors.
   c) Discrete Outputs: Two individually adjustable relay outputs.
5) Enclosure:
   a) Mounting: Case; slide-out single instrument panel mount.
   b) Size: 1/4 DIN.
   c) Chassis: Metallic.
6) Power: 120V ac, 60 Hertz.
7) Manufacturer: Yokogawa Corporation of America UT37/LPS.

C. Y50 PLC Component Specifications:

1. General Specifications:
   a. Operating Temperature: 0 to 60 degrees C.
   b. Humidity: 50 to 95 percent noncondensing.
   c. Operating Voltage: 120 volts, 60 Hz (plus or minus 10 percent).
2. Central Processor:
   a. The central processing unit, CPU, shall be, as a minimum, a 32-bit microprocessor that provides system timing, performs online diagnostics, and processes the user program. The CPU shall be capable of performing the same functions as a conventional analog and relay logic system, including relays, timers, counters, shift registers, and drum sequencers. The CPU shall also be capable of data word functions such as four-function floating point math, scale data, data shift registers, data word move, data file compare, and logic functions such as and, or, not, PID loop control, square root, and powers of X.
   b. The CPU shall be capable of addressing up to 960 discrete I/O. Scan time shall be 2.0 milliseconds maximum per 1,000 words of typical ladder logic. The CPU shall be capable of RS-232 communication.
   c. The CPU shall sample the discrete and analog input/output system, including internal discrete and word values. The CPU then processes the I/O with the user program stored in ladder memory, then controls the output based on the results of the logic operation. The CPU shall execute the user program by rapidly scanning the ladder memory. Both logic and word type functions are executed in the order they appear in the program. Each ladder rung is processed, then the results of that rung shall be available to the next logic rung.
   d. The CPU shall perform online diagnostics that monitor the internal operation of the programmable control. If a failure is detected, the CPU shall initiate an orderly system shutdown. As

a minimum, the CPU shall monitor the following system failures and initiate a system shutdown if a failure occurs:
1) Memory failure.
2) User program longitudinal redundancy error.
3) Memory battery low.
4) Input/output subsystem error.
5) Watchdog timer time out.

e. The processor memory shall be read/write random access memory (RAM) with an integral battery backup that will maintain the memory for a minimum of 2 years with no external electrical power. The memory provided shall be configurable from the programming unit. The size of the memory shall be sufficient to implement the specified functions plus 50 percent spare and shall be at least 12K words.
f. Memory backup shall be plug-in type EEPROM read only modules, Allen-Bradley; Catalog No. 1747-M11.
g. The CPU shall occupy one slot in the local hardware rack.
h. Manufacturer and Product: Allen-Bradley; SLC 5/03 Catalog No. 1747-L532.

3. Power Supply:
   a. The power supply shall mount to the side of the hardware rack and supply power to the CPU and I/O modules.
   b. Input Voltage: 85 to 132VA, minimum.
   c. Internal Capacity: 5a at 5V dc and .96A at 24V dc, minimum.
   d. Manufacturer and Product: Allen-Bradley; Catalog No. 1746-P2.
4. Hardware Rack:
   a. The hardware rack shall house the CPU module and all I/O modules necessary for the PLCS. The power supply shall mount on the left side of the rack.
   b. The rack shall be constructed such that all components will slide easily in and out. No tools shall be necessary to install or remove modules.
   c. The rack shall provide sufficient slots to house the required number of modules plus spare capacity, 7 slots, minimum.
   d. If a single rack is not sufficient to hold the required number of modules, provide additional racks and interconnecting cables as necessary.
   e. Manufacturer and Product: Allen-Bradley; Catalog No. 1746-A7.
5. Discrete Input:
   a. The PLCS discrete inputs shall be 120V ac, 60 Hz signals imposed on the input module. Input signals shall be optically isolated from logic circuits.
   b. The input modules shall have noise filters or use other techniques to reject short time constant noise and 60-Hz pickup. Individual input points shall be capable of withstanding low energy common mode transients to 1,500 volts without catastrophic failure.
   c. The input module shall have individual status light for each input and shall have barrier type terminal blocks for termination of the field wires. The module shall be constructed such that the field

wires do not have to be removed while replacing the module. Each module shall accept eight inputs.

d. Manufacturer and Product: Allen-Bradley Catalog No. 1746-IA8.

6. Discrete Outputs:
   a. The PLCS discrete outputs shall be as an isolated contact closure. The output module shall provide a contact output rated for 5 amps continuous at 120 volts ac or 2 amps continuous at 24 volts dc, minimum. The discrete outputs shall open when an internal PLC failure is detected.
   b. Discrete output modules shall have individual status lights for each output point, and shall have barrier type terminal blocks for termination of the input/output wires. The module shall be constructed such that the field wires do not have to be removed while replacing the module. Each module shall provide eight individually isolated outputs.
   c. Manufacturer and Product: Allen-Bradley Catalog No. 1746-OX8.
7. Analog Inputs:
   a. The analog input modules shall be suitable for accepting 1 to 5V or 4 to 20 mA dc signals. The inputs shall have 12 bit resolution and shall be capable of withstanding common mode transients of 1500V peak.
   b. The module shall be constructed such that field wires do not have to be removed while replacing the module. Each module shall accept four inputs.
   c. Manufacturer and Product: Allen-Bradley; Catalog No. 1746-NI4.
8. Analog Outputs:
   a. the analog output modules shall be capable of providing isolated 4 to 20 mA dc signals. Each module shall have four outputs.
   b. The module shall be constructed such that the field wires do not have to be removed while replacing the module.
   c. Manufacturer and Product: Allen-Bradley Catalog No. 1746-NO4I.
9. PLCS Cables: Provide cables as required to interconnect the PLC with other system equipment.

D. Y51 PLCS Programming System:

1. The programming system shall consist of the following items, as a minimum:
   a. Personal computer, 32-bit, IBM compatible.
      1) Type: Laptop or notebook style.
      2) Processor: Intel 486.
      3) Clock Speed: 33 MHz, minimum.
      4) RAM: 8-Mbyte, minimum, expandable to 32 Mbytes.
      5) Floppy Disk Drive:3-1/2-inch, 1.44-Mbyte.
      6) Hard Disk Drive: 100-Mbyte, minimum.
      7) Display: VGA, suitable for use in low light situations.
      8) Serial Communications Port: One, minimum.
      9) Parallel Printer Port: One, minimum.
      10) Battery pack and charger unit.

11) Carrying case with shoulder strap, storage pockets, and space for battery, charger, power cords, and PLC communications cable.
12) Manufacturer: Compaq, most current product offering.

b. Standard Software:
1) MS-DOS operating system, latest version, compatible with the PLC programming software.
2) Microsoft Windows, latest version.

2. The PLC programming system shall be an easy to use menu-driven system and shall provide for entering into the memory of the programmable control system the user ladder logic program and analog functions. The ladder logic shall be entered in the form of relay ladder diagram notation. The entered ladder logic shall be displayed on the programmer cathode ray tube (CRT) or liquid crystal display (LCD). The programmer shall have the capability to store the programmable control system memory on a floppy disk for a permanent record of the programs. The programmer shall also be capable of developing programs while not connected to the PLC, then downloading the program in to the PLC. All memory transfers shall be verified.

3. The programmer unit shall provide a means for supervising the functions of the operating programmable system. In particular, the programming unit shall be able to:
a. Monitor or alter the status of any internal relay, timer, counter, or other logic element.
b. Monitor any controller input or output.
c. Initiate diagnostic tests to functional check out the processor and operator interfaces.
d. Force both analog and discrete inputs and outputs, including internal coils.
e. Find logic elements, inputs, outputs, and data words.
f. Monitor and reset system alarms.

4. The programming unit shall provide a means of documenting and printing the user program. the documentation system shall, as a minimum, consist of rung comments, elements names, I/O cross reference, and memory configuration. Each logic element shall have an assignable synonym. The I/O cross reference shall give coil and contact location of all logic elements.
a. Manufacturer and Product: Allen-Bradley; Advanced Programming Software, Catalog No. 1747-PA2E, latest version.

E. Other components shall be as specified in Section 16050, BASIC MATERIALS AND METHODS.

2.5 FACTORY FINISHING

A. Enclosure:

1. Primer: One coat of rust-inhibiting coating, 2 mils dry film thickness.
2. Finish, Alkyd Enamel:
a. Interior: Two coats white, 4 mils dry film thickness.
b. Exterior: Two coats manufacturer's standard gray or ANSI 359-A-1-88, No. 61, 4 mils dry film thickness.

2.6 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all control panels actually furnished.

C. Record test data for report.

D. Functional Test: Perform manufacturer's standard.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

3.2 FIELD QUALITY CONTROL

A. Functional Test:

1. Conduct on each controller and level contol system.
2. Inspect controller for electrical supply termination connections, interconnections, proper installation, and quiet operation.
3. Verify calibration and operation of instruments and PLC I/O.
4. Verify proper operation of the functional requirements.
5. Record test data for report.

B. Performance Test:

1. Conduct on each controller and level control system.
2. Perform under actual or approved simulated operating conditions.
3. Test for continuous 12-hour period without malfunction.
4. Demonstrate performance by operating the continuous period while varying the application load, as the input conditions allow, to verify system performance.
5. Record test data for report.
6. With plant load connected to utility source, measure the following to show parameters within specified limits:
   a. Total and individual current harmonic distortion (up to and including 35th harmonic) at drive line terminals under following load conditions:
      1) AFDs running at full load and half load.
      2) Half of the specified AFDs running at full load and half load.
   b. Power factor at input side of each drive. Documented verification that power factor is maintained at 95 percent as speed of drive goes down from 100 percent to 33 percent.

C. Test Equipment:

1. Use Dranetz, Model No. 626-PA, harmonic distortion monitor and Series 626 disturbance analyzer or equivalent instrument to document results.
2. Provide diagnostic plug-in test card complete with instructions, multiposition selector switch, and meters or built-in diagnostic control panel or ROM-based processor for monitoring ac, dc, and digital signals to assist in troubleshooting and startup of drive.

3.3 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at site or classroom designated by OWNER, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 2 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for prestartup classroom or site training.
4. 1 person-day for facility startup.
5. 2 person-days for post-startup training of OWNER's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by RESIDENT ENGINEER.

B. See Section 01640, MANUFACTURERS' SERVICES.

END OF SECTION

SECTION 16500
LIGHTING

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Interior Luminaires:
   a. Catalog data sheets and pictures.
   b. Luminaire finish and metal gauge.
   c. Lens material, pattern, and thickness.
   d. Candle power distribution curves in two or more planes.
   e. Candle power chart 0 to 90 degrees.
   f. Lumen output chart.
   g. Average maximum brightness data in foot lamberts.
   h. Coefficients of utilization for zonal cavity calculations.
   i. Mounting or suspension details.
2. Exterior Luminaires:
   a. Catalog data sheets and pictures.
   b. Luminaire finish and metal gauge.
   c. Lens material, pattern, and thickness.
   d. IES lighting classification and isolux diagram.
   e. Fastening details to wall or pole.
   f. Ballast type, location, and method of fastening.
   g. For light poles, submit wind loading, complete dimensions, and finish.
3. Lamps:
   a. Voltages.
   b. Colors.
   c. Approximate life (in hours).
   d. Approximate initial lumens.
   e. Lumen maintenance curve.
   f. Lamp type and base.
   g. Copy of lamp order, including individual quantities, for Project.
4. Ballasts:
   a. Type.
   b. Wiring diagram.
   c. Nominal watts and input watts.
   d. Input voltage and power factor.
   e. Starting current, line current, and restrike current values.
   f. Sound rating.
   g. Temperature rating.
   h. Efficiency ratings.
   i. Low temperature characteristics.
   j. Emergency ballasts rating and capacity data.
5. Photo-Time Control:
   a. Wiring diagram.
   b. Contact ratings.

6. Photocells:
   a. Voltage, and power consumption.
   b. Capacity.
   c. Contacts and time delay.
   d. Operating levels.
   e. Enclosure type and dimensions.
   f. Temperature range.

1.2 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

B. Assembled fixture, complete with lamps, shall be in accordance with State of California Title 24 requirements.

1.3 SPARE PARTS

A. Extra Materials: Furnish, tag, and box for shipment and storage and deliver prior to 90 percent Project completion the following spare parts, and materials:

1. Two spare ballast of each type.
2. Two spare lamps of each type.

PART 2 PRODUCTS

2.1 LUMINAIRES

A. Specific requirements relative to execution of Work of this section is located in the Luminaire Schedule on Drawings.

B. Feed-through type, or separate junction box.

C. Ballasts: Two-lamp when possible.

D. Wire Leads: Minimum 18 AWG.

E. Component Access: Accessible and replaceable without removing luminaire from ceiling.

F. Soffit Installations:

1. UL Labeled: SUITABLE FOR DAMP LOCATIONS.
2. Ballast: Removable, prewired.

G. Exterior Installations:

1. UL Labeled: SUITABLE FOR WET LOCATIONS.
2. Ballast: Removable, prewired.
3. When factory-installed photocells are provided, entire assembly shall have UL label.

2.2 LAMPS

A. Fluorescent:

1. Type Efficiency: Energy.
2. Color: Cool white.

B. High Intensity Discharge:

1. Type: High pressure sodium.
2. Color: Clear.

C. Incandescent:

1. Type Efficiency: Energy.
2. Color: Inside frosted.

D. Incandescent Quartz: Clear.

E. Tungsten Halogen:

1. Type Efficiency: Energy.
2. Color: Clear.

F. Manufacturers:

1. General Electric.
2. Sylvania.
3. North American Phillips.

2.3 BALLASTS

A. General:

1. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
2. Certified by electrical testing laboratories to conform to Certified Ballast Manufacturer's specifications.

B. Fluorescent:

1. Type: High power factor, energy efficient, rapid-start type ballast, compatible with lamps specified.
2. Sound Rating: Minimum A, maximum allowable noise level of 30 decibels measured 2 feet from installed fixture.
3. Class: P.
4. Automatic resetting, thermo-protector to prevent case temperature from exceeding 110 degrees C in the event of a short circuit.

C. Metal Halide:

1. High power factor, normal ambient, 180 degrees C insulation class.

2. Types:
   a. Autotransformer with capacitor and ignitor for lamps 150 watts and less.
   b. Constant wattage autotransformer with capacitor for lamps above 150 watts.

D. High Pressure Sodium:

1. High power factor, normal ambient, 180 degrees C insulation class, with capacitor and ignitor.
2. Type:
   a. Autotransformer for 50-watt lamps.
   b. Constant wattage autotransformer for lamps 70 watts and above.

E. Manufacturers:

1. MagneTec Jefferson.
2. Advance Transformer.
3. Universal.

2.4 LIGHTING CONTROL

A. Photocell:

1. Automatic ON/OFF switching photo control.
2. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.
3. Setting: ON at dusk and OFF at dawn.
4. Time delay feature to prevent false switching.
5. Field adjustable to control operating levels.
6. Manufacturers:
   a. Tork.
   b. Paragon.

PART 3 EXECUTION

3.1 LUMINAIRES

A. General:

1. Install in accordance with manufacturer's recommendations.
2. Provide proper hangers, pendants, and canopies as necessary for complete installation, and meeting specified seismic requirements.
3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building required to safely mount.
4. Install plumb and level.
5. Mounting heights shown for wall mounted or pendant mounted luminaires are measured from bottom of luminaire to finished floor or finished grade, whichever is applicable.
6. Install each luminaire outlet box with galvanized stud.

B. Pendant Mounted:

1. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
2. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart.
3. Provide twin-stem hangers on single luminaires.

C. Swinging Type: Provide, at each support, safety cable capable of supporting four times the vertical load from the structure to the luminaire.

D. Finished Areas:

1. Install symmetrically with tile pattern.
2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.
4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use fixtures suitable for mounting on low density ceilings.
5. Junction Boxes:
   a. Flush and Recessed Luminaires: Locate minimum 1 foot from luminaire.
   b. In concealed locations, install junction boxes to be accessible by removing luminaire.
6. Wiring and Conduit:
   a. Provide wiring of temperature rating required by luminaire.
   b. Provide flexible steel conduit.
7. Provide plaster frames when required by ceiling construction.
8. Independent Supports:
   a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft-annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.
   b. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.
   c. Fasten chain or wire to each end of luminaire.

E. Unfinished Areas: Locate luminaires to avoid either conflict with other building systems or blockage of luminaire light output.

1. Fixture Suspension: Provide 3/8-inch threaded steel hanger rods. Scissor type hangers not permitted.
2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

3.2 LAMPS

A. Provide in each fixture, the number and type for which the fixture is designed, unless otherwise noted.

3.3 BALLASTS

A. Install in accordance with manufacturer's recommendations.

B. Utilize all ballast mounting holes to fasten securely within luminaire.

C. Replace noisy or defective ballasts.

3.4 LIGHTING CONTROL

A. Outdoor Luminaires: Photocells switch lights ON at dusk and OFF at dawn.

3.5 CLEANING FOLLOWING CONSTRUCTION

A. Remove all labels and other markings, except UL listing mark.

B. Wipe luminaires inside and out to remove construction dust.

C. Clean luminaire plastic lenses with antistatic cleaners only.

D. Touch up all painted surfaces of luminaires and poles with matching paint ordered from manufacturer.

E. Replace all *defective* lamps at time of Substantial Completion.

END OF SECTION

SECTION 16723
CLOSED CIRCUIT TELEVISION SURVEILLANCE SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work necessary to design, furnish, and install a CCTV security surveillance system for the upstream and downstream dams.

1.2 WORK INCLUDED

A. All work pertinent to the CCTV security surveillance system shall be done by a qualified, competent, licensed, security system contractor with a minimum of 5 years' experience providing similar systems.

B. Furnish detailed design, equipment, materials, and labor required to provide a complete, satisfactory, and ready to operate CCTV security surveillance system.

C. Upon completion of installation, adjust, calibrate, and start up the system. Demonstrate proper operation of all components and the system as a whole to the satisfaction of the OWNER. Provide a minimum of one 8-hour day for instruction of OWNER's personnel in the operation and maintenance of the system.

1.3 SUBMITTALS

A. Submittals during construction shall be made in accordance with Section 01300, SUBMITTALS. In addition, the following specific information shall be provided:

1. CCTV system contractor statement of qualifications.
2. Overall system block diagram.
3. Complete bill of materials.
4. Complete descriptive information on all equipment and materials.
5. Installation details and elementary wiring diagrams.

B. O&M Manuals: Submit in accordance with Section 01430, OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 GENERAL

A. Like Items of Materials: Provide end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, replacement, and manufacturer's service.

B. All equipment included under this section, regardless of manufacturer, shall be provided by one supplier who shall assume full responsibility for coordination and proper operation of the complete system.

1. ASSI Security of Arizona, Phoenix, AZ.
2. Or approved equal.

C. Using the functional requirements as a guide, complete the design and provide equipment as necessary to implement the required functions.

D. Coordinate with the supplier of the camera supports shown on the Drawings to provide a secure mount with a minimum 120 degrees of camera rotation.

2.2 FUNCTIONAL REQUIREMENTS

A. Required Functions at Each Camera Location (four sites):

1. Receive PAN/TILT/ZOOM, (PTZ) control commands from the operations building equipment and execute those commands.
2. Continuously monitor the rubber dam and riverbed as controlled by the Papago Plant operator. Provide a minimum of 180 degrees pan and 60 degrees tilt above or below horizontal.
3. Transmit video signals to the operations building equipment.
4. Survive and function in the outdoor environment without degradation due to sun, heat, wind, rain, or other conditions normally encountered.

B. Required Functions at Each Operations Building (two sites):

1. Communicate with the Papago Water Treatment Plant at 115 Kb, full duplex, via spread spectrum 900 MHz radio.
2. Receive video signals from two remote camera locations, convert those signals to radio, and transmit to the Papago Water Treatment Plant.
3. Receive radio PTZ control signals from Papago Water Treatment Plant: Convert and transmit them to the camera locations.
4. Generate and transmit alarms for motion detection in either of the two cameras views.

C. Required Functions at the Papago Water Treatment Plant (one site):

1. Communicate with the dam operations buildings at 115 Kb, full duplex, via spread spectrum 900 MHz radio.
2. Receive radio signals from two remote operations buildings and route those signals to the control room.
3. Convert the received signals to video and display on two individual monitors.
4. Record the video on two individual VCRs.
5. One monitor and VCR will be used for both camera signals from one dam. Display and record one or both views simultaneously through the use of "split screen" switching, operator selectable.

6. Provide operator control of PTZ units for each remote camera. Transmit control signals to the operations buildings.
7. Provide an audible alarm for motion sensed in any of the four views. The operator shall be able to silence the alarm.

2.3 EQUIPMENT

A. Major system components are shown on the Drawings, CCTV block diagram, and listed here. No attempt has been made to identify all necessary items. Supply all additional equipment, materials, and labor necessary to provide a complete functioning system.

Item	Qty	Description	Manufacturer/Product
1	4	Camera, 1/2-inch monochrome CCD, 24V ac, EIA RS-170	PELCO, PCHM575
2	4	10X motorized zoom lens with spot filter, automatic iris, and presets, 8-80 mm, f1.2	PELCO, TVH10AC
3	4	Camera environmental enclosure, heavy duty with sun shield	PELCO, EH5723L
4	4	Blower kit for environmental enclosure	PELCO, BK57
5	4	Pan/tilt drive unit, heavy duty, 52 lb load adjustable limit stops, corrosion-resistant worm gear, and quick-connect features, 24V ac	PELCO, Legacy PT780
6	4	Control receivers, PTZ receiver with local switches and remote preset capability, 24V ac	KALATEL, KTD-125-24-P
7	4	Spread spectrum radio modem, 115 Kb full duplex, industrial grade, -10 to 60 degrees C, 902-926 MHz, no FCC license required, RS232 interface, 120V ac	Industrial Modem RF115
8	4	Antenna, as required for reliable transmission and reception	**
9	4	115 Kb short-haul modem, as required to reliably transmit data between the control room and the actual transmission location	**
10	2	Video motion detection system, adjustable sensitive area, multiple camera inputs, alarm outputs, RS485 port, external alarm input, 1V p-p video input, two video outputs per channel	ADPRO, VMD 10/2

11	2	Video transmitter module, compatible with motion detection system	ADPRO, VM 40
12	2	Video receiver, ten video inputs, ten control inputs, RS232 port, ten alarm outputs, one video output	ADPRO, VST 10
13	1	Programmer	ADPRO, 220253
14	2	Programmer	ADPRO, 220311
15	2	Monitor, 17" diag. black and white, 725 lines resolution minimum 32 dB video gain minimum 75 ohm impedance, 120V ac	ULTRAK, KM-17
16	2	Video cassette recorder, four-head, VHS, 8- or 24-hour real time video and audio, automatic alarm marking and tape end alarm output, built-in time/date with battery backup	SANYO, SRT500
17	**	Data signal distributor	KALATEL, KTD-83
18	**	Data converter, interface RS232 with RS422 and vice versa	KALATEL, KTD-87
19	**	Transient voltage suppression devices. Provide for all power, video, and data lines	DITEK, DTVSPBNCA, DTK1LVLP, DTK120HW
20	**	All necessary equipment enclosures, panels and racks, mounting hardware, cables, wiring, connectors, etc., necessary for a complete system	**
**As required			

PART 3 EXECUTION

3.1 GENERAL

A. Install all equipment in accordance with manufacturer's instructions.

B. Prewire and preassemble components and panels where possible. Minimize field wiring and fabrication.

C. Install all conduit, wire, and cable necessary for operation, whether or not specifically shown on the Drawings, in accordance with Division 16 Specifications.

3.2 MANUFACTURERS' SERVICES

A. Testing:

1. Perform manufacturer's standard tests on all equipment.
2. Demonstrate proper operation of all components and the system as a whole to the satisfaction of the OWNER.

B. Training: Provide a minimum of one 8-hour day of instruction for OWNER's personnel in the operation and maintenance of the system.

END OF SECTION

SECTION 16950
ELECTRICAL TESTING

PART 1 GENERAL

1.1 SUBMITTALS

A. Administrative Submittals: Submit 30 days prior to performing inspections or tests:

1. Schedule for performing inspection and tests.
2. List of references to be used for each test.
3. Sample copy of equipment and materials inspection form(s).
4. Sample copy of individual device test form.
5. Sample copy of individual system test form.

B. Quality Control Submittals: Submit within 30 days after completion of test:

1. Test or inspection reports and certificates for each electrical item tested.

C. Contract Closeout Submittals:

1. Operation and Maintenance Data: After test or inspection reports and certificates have been reviewed by RESIDENT ENGINEER and returned, insert a copy of each in operation and maintenance manual.

1.2 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers, of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologists (NICET), or International Electrical Testing Association and having a minimum of 5 years testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to project at ratio not to exceed two certified to one noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA Title 29, Part 1907 criteria for accreditation of testing laboratories or a full Member Company of International Electrical Testing Association.

B. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

C. Test instrument calibration shall be in accordance with NETA ATS.

1.3 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment are to be:

1. Scheduled with OWNER prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify OWNER at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

A. Tests specified in this section are to be performed in accordance with the requirements of Section 01650, FACILITY STARTUP.

B. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer's tolerances.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Adjust mechanisms and moving parts for free mechanical movement.

E. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

F. Verify nameplate data for conformance to Contract Documents.

G. Realign equipment not properly aligned and correct unlevelness.

H. Properly anchor electrical equipment found to be inadequately anchored.

I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

K. Provide proper lubrication of applicable moving parts.

L. Inform RESIDENT ENGINEER of working clearances not in accordance with NFPA 70.

M. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

N. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by RESIDENT ENGINEER, door and panel sections having dented surfaces.
5. Repair or replace, as determined by RESIDENT ENGINEER, poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
   a. Provide matching paint and touch up scratches and mars.
   b. If required due to extensive damage, as determined by RESIDENT ENGINEER, refinish the entire assembly.

O. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

3.2 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.
8. Cleanliness and improper blockage of ventilation passages.

9. Verify that tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.2.3 for each:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. 10-minute test duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
   c. Results temperature corrected in accordance with NETA ATS, Table 7.2.4.
   d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.3 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Power Cable No. 8 and Larger For:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.
   c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
   d. Color coding conformance with specifications.
   e. Proper circuit identification.
2. Mechanical Connections For:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.
4. Control Cables For:
   a. Proper termination.
   b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 8 and Larger:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.
   b. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.
   c. Evaluate ohmic values by comparison with conductors of same length and type.
   d. Minimum Acceptable Value: 50 megohms.

C. Continuity test by ohmmeter method to ensure proper cable connections for all conductors.

3.4 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 100 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 10.1.
6. Operate breaker to verify smooth operation.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480- and 600-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 10.2.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.

e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
f. Trip times shall be within limits established by NEMA AB 4, Table 5-3.
g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4.

3.5 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually Check Current, Potential, and Control Transformers For:
   a. Cracked insulation.
   b. Broken leads or defective wiring.
   c. Proper connections.
   d. Adequate clearances between primary and secondary circuit wiring.
2. Verify Mechanically That:
   a. Grounding and shorting connections have good contact.
   b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
3. Verify proper primary and secondary fuse sizes for potential transformers.

B. Electrical Tests:

1. Current Transformer Tests:
   a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.
   b. Polarity test.
2. Potential Transformer Tests:
   a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 7.1.1 for 1 minute on:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.
3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

3.6 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify that meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.7 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control centers and panelboards for proper connection and tightness.
2. Ground bus connections in motor control centers for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

1. Fall-Of-Potential Test:
   a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
   b. Main ground electrode system resistance to ground to be no greater than 1 ohm.
2. Two-Point Direct Method Test:
   a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
   b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

3.8 GROUND FAULT SYSTEMS

A. Inspection and Testing Limited To:

1. Zero sequence grounding systems.
2. Residual ground fault systems.

B. Visual and Manual Inspection:

1. Neutral Main Bonding Connection to Assure:
   a. Zero sequence sensing system is grounded ahead of neutral disconnect link.
   b. Ground strap sensing system is grounded through sensing device.
   c. Neutral ground conductor is solidly grounded.
2. Verify that control power has adequate capacity for system.
3. Manually Operate Monitor Panels For:
   a. Trip test.
   b. No trip test.
   c. Nonautomatic rest.
4. Zero sequence system for symmetrical alignment of core balance transformers about current carrying conductors.
5. Relay check for pickup and time under simulated ground fault conditions.
6. Verify nameplate identification by device operation.

C. Electrical Tests:

1. Test system neutral insulation resistance with neutral ground link removed. System neutral insulation resistance minimum 1 megohm.
2. Determine relay pickup by primary current injection at the sensor. Relay pickup current within plus or minus 10 percent of device dial or fixed setting.
3. Test relay timing by injecting 300 percent of pickup current, or as specified by manufacturer. Relay operating time in accordance with manufacturer's time-current characteristic curves.
4. Test system operation at 55 percent rated control voltage, if applicable.
5. Test zone interlock system by simultaneous sensor current injection and monitoring zone blocking functions.

3.9 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 5 hp and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate Motor and Check For:
   a. Excessive mechanical and electrical noise.
   b. Overheating.
   c. Correct rotation.
   d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
   e. Excessive vibration.
5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:
      1) Motors above 200 hp for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
      2) Motors 200 hp and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
   b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
2. Calculate polarization index ratios for motors above 200 hp. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

3.10 LOW VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.
7. Check Door and Device Interlocking System By:
   a. Closure attempt of device when door is in OPEN position.
   b. Opening attempt of door when device is in ON or CLOSED position.
8. Check Nameplates for Proper Identification Of: Equipment title and tag number with latest one-line diagram.
9. Verify that fuse and circuit breaker sizes and types conform to Contract Documents.
10. Verify that current and potential transformer ratios conform to Contract Documents.
11. Check Bus Connections for High Resistance by Low Resistance Ohmmeter and Calibrated Torque Wrench Applied to Bolted Joints:
    a. Ohmic value to be zero.
    b. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
12. Check Operation and Sequencing of Electrical and Mechanical Interlock Systems By:
    a. Closure attempt for locked open devices.
    b. Opening attempt for locked closed devices.
    c. Key exchange to operate devices in OFF-NORMAL positions.
13. Verify performance of each control device and feature furnished as part of the motor control center.
14. Control Wiring:
    a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
    b. Check for proper conductor lacing and bundling.
    c. Check for proper conductor identification.
    d. Check for proper conductor lugs and connections.
15. Exercise active components.
16. Inspect Contactors For:
    a. Correct mechanical operations.
    b. Correct contact gap, wipe, alignment, and pressure.
    c. Correct torque of all connections.
17. Compare overload heater rating with full-load current for proper size.
18. Compare motor protector with motor characteristics and power factor correction capacitors for proper size.
19. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.
   b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
   c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
   d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
   e. Test values to comply with NETA ATS, Table 10.2.
2. Overpotential Tests:
   a. Maximum applied ac or dc voltage in accordance with NETA ATS, Table 7.1.2.
   b. Phase-to-phase and phase-to-ground for 1 minute for each phase of each bus section.
   c. Test results evaluated on pass/fail basis.
3. Current Injection Through Overload Unit at 300 Percent of Motor Full-Load Current and Monitor Trip Time:
   a. Trip time in accordance with manufacturer's published data.
   b. Investigate values in excess of 120 seconds.
4. Control Wiring Tests:
   a. Apply secondary voltage to control power and potential circuits.
   b. Check voltage levels at each point on terminal boards and each device terminal.
   c. Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components.
      1) Insulation resistance to be 1 megohm minimum.
5. Operational test by initiating control devices to affect proper operation.

3.11 LOW VOLTAGE SURGE ARRESTORS

A. Visual and Mechanical Inspection:

1. Adequate clearances between arrestors and enclosures.
2. Ground connections to ground bus.

B. Electrical Tests:

1. Varistor Type Arrestors:
   a. Clamping voltage test.
   b. Rated RMS voltage test.
   c. Rated dc voltage test.
   d. Varistor arrester test values in accordance with ANSI C62.33, Sections 4.4 and 4.7.

END OF SECTION

APPENDIX

US COE Section 404 Permit

US EPA National Pollution Discharge Elimination System Permit

Arizona Department of Environmental Quality State Water Quality Certification

Arizona Department of Water Resources Dam Safety (Not Included)

Arizona Department of Water Resources Recovery Well Permit

Arizona Department of Transportation Permit (Not Included)

Flood Control District of Maricopa County (Not Included)

City of Tempe Building Permit (Not Included)

Union Pacific Railroad Company (Not Included)

Arizona Public Service

Salt River Project (Not Included)

DEPARTMENT OF THE ARMY PERMIT

Permittee:

City of Tempe
City Engineer's Office
Mr. Howard Hargis
P.O. Box 5002
Tempe, Arizona 85280

Permit Number: 94-40904-00-CJL

Issuing Office: Los Angeles District

Note: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: To construct the City of Tempe's 200 acre Rio Salado Town Lake as shown on the attached drawings. Activities within the waters of the United States include construction of an upstream and downstream air-inflatable rubber dam, foundations, energy dissipating structures, slurry wall installations, channel grading, material storage during construction, and a stormwater detention/riparian area.

Project Location: In the Salt River between Priest Drive and McClintock Drive, at (Sections 14, 15, and 16, T1N, R4E), Tempe, Maricopa County, Arizona.

Permit Conditions

General Conditions:

1. The time limit for completing the authorized activity ends on April 22, 1998. If

you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification from this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished with the terms and conditions of your permit.

Special Conditions: See attached sheet.

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

( ) Section 10 of the River and Harbor Act of 1899 (33 U.S.C. 403).

( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

(X) Section 404 of the Clean Water Act (33 U.S.C. 1344).

2. Limits of this authorization.

a. This permit does not obviate the need to obtain other Federal, state, or local authorizations required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or behalf of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision. This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

a. You fail to comply with the terms and conditions of this permit.

b. The information provided by you in support of your permit application

proves to have been false, incomplete, or inaccurate (See 4 above).

c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measure ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions. General condition 1 establishes a time limit for the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give you favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

Howard C. Hargis 4/21/95

(PERMITTEE) (DATE)

Assistant City Engineer

Howard C. Hargis, P.E., Assistant City Engineer

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

Diane K. Noda 4 May 1995

Diane K. Noda (DATE)

Acting Chief, Regulatory Branch

(for the District Engineer)

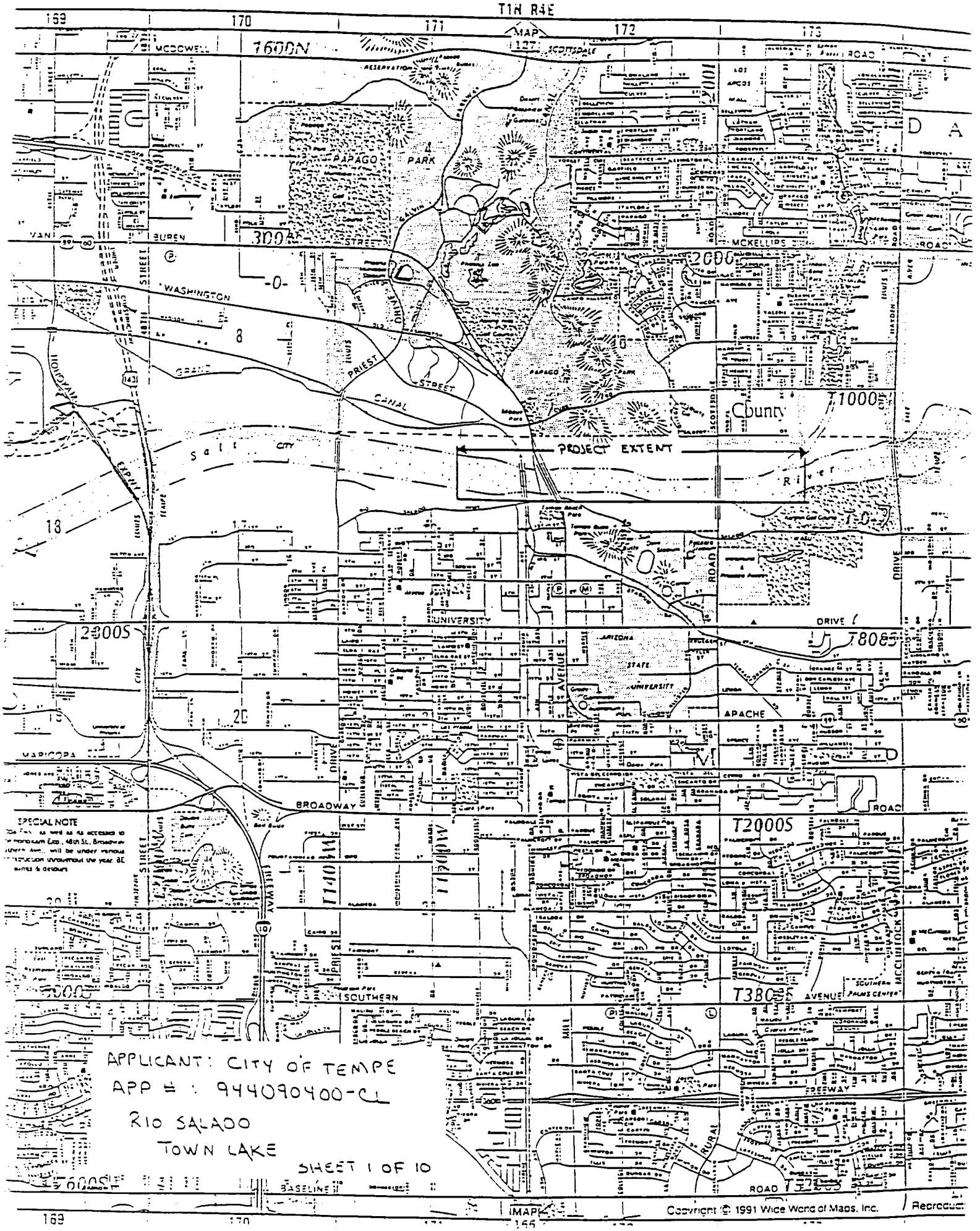
When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

_____ _____

(TRANSFEREE) (DATE)

SPECIAL CONDITIONS
PERMIT NO. 94-40904-00-CJL

1. The permittee shall abide by the terms and conditions of the attached letter of water quality certification issued by the Arizona Department of Environmental Quality on March 13, 1995.


T1N R4E
169
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MAP 127
MCDOWELL
1600N
SCOTTSDALE
ROAD
PAPAGO
PARK
VAN BUREN
STREET
300N
MCKELLIPS
ROAD
2000
WASHINGTON
PRIEST
STREET
GRAND
CANAL
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PROJECT EXTENT
River
UNIVERSITY
DRIVE
2000S
T8000
ARIZONA
STATE
UNIVERSITY
APACHE
MARICOPA
BROADWAY
ROAD
SPECIAL NOTE
T2000S
AVENUE
SOUTHERN
T3000S
AVENUE
MCCLINTOCK
FREEWAY
RURAL
ROAD
BASELINE
T4000S
APPLICANT: CITY OF TEMPE
APP # : 944090400-CL
RIO SALADO
TOWN LAKE
SHEET 1 OF 10
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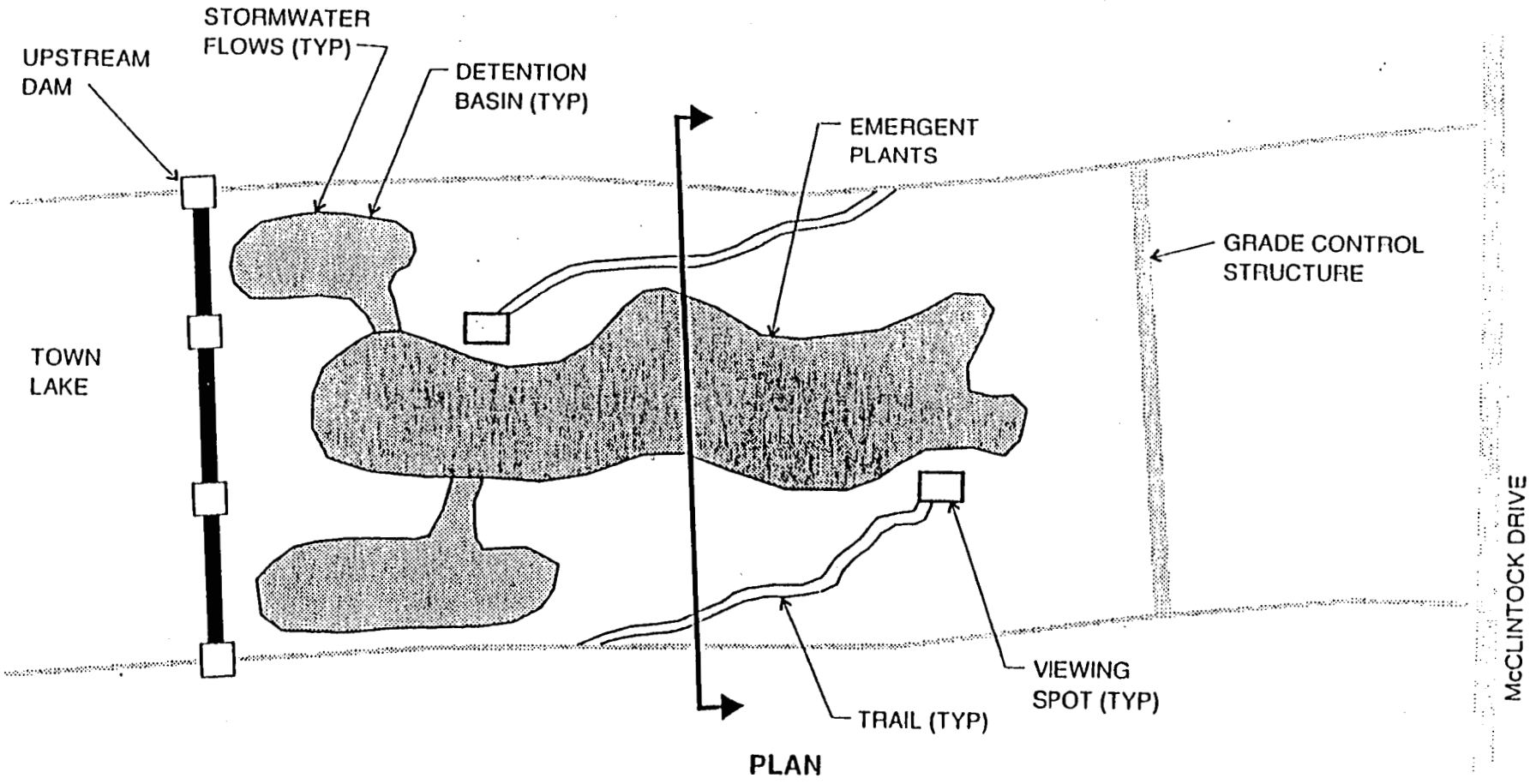
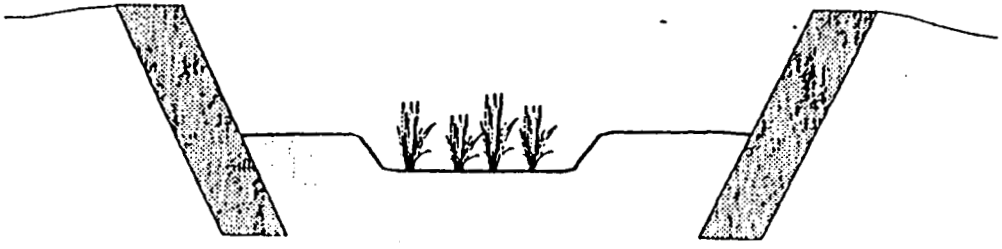




SECTION

APPL: CITY OF TEMPE
APPL #: 9440909 00-CL
SHEET 3 OF 10

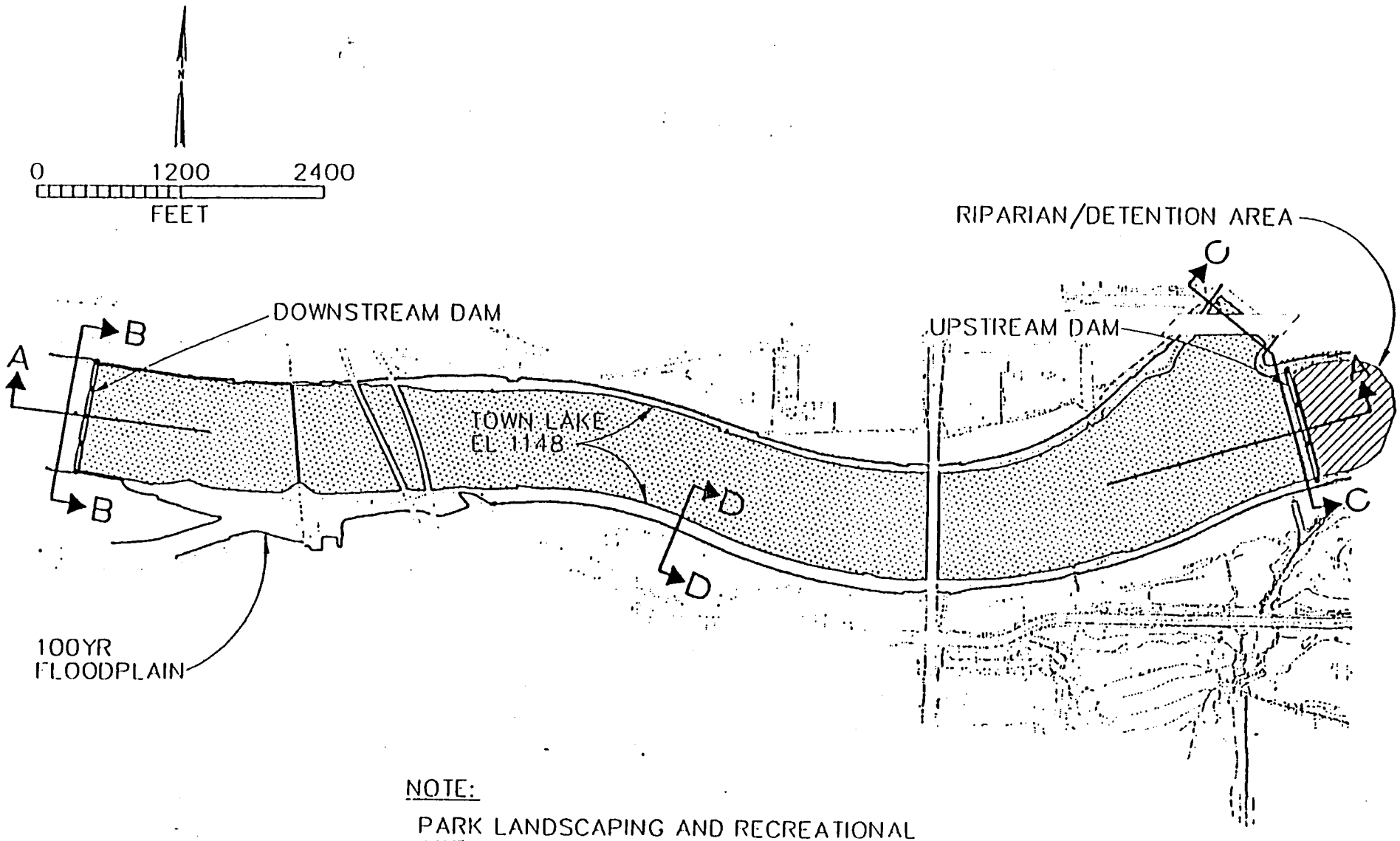
RIPARIAN/DETENTION AREA

Rio Salado COE 404
Permit Application

CH2M HILL

06 17 94

05-19-94



NOTE:

PARK LANDSCAPING AND RECREATIONAL AREAS WILL BE CREATED AROUND THE PERIMETER OF THE LAKE.

APPL: CITY OF TEMPE
APPL #: 944090400-CL

SHEET 5 OF 10

TOWN LAKE PLAN

RIO SALADO COE 404
PERMIT APPLICATION

CH2M HILL

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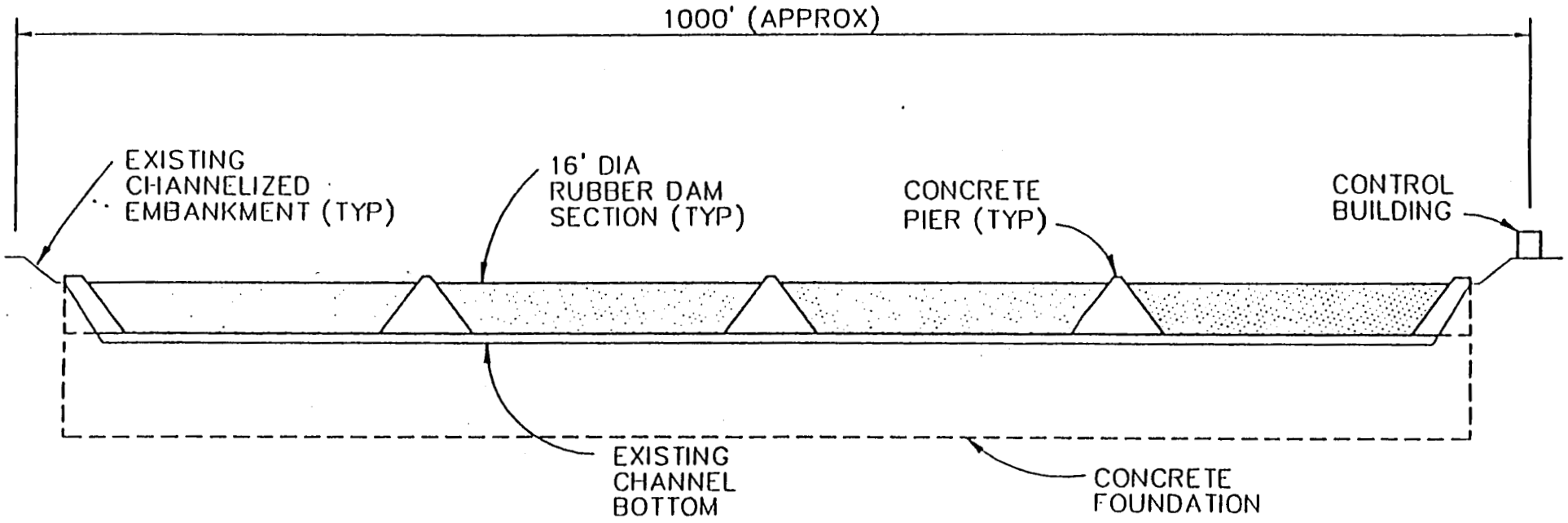
05-18-94



APPL: CITY OF TEMPE
APPL #: 944090400-CL

SHEET 1 OF 10

SECTION B-B

RIO SALADO COE 404
PERMIT APPLICATION

CH2M HILL

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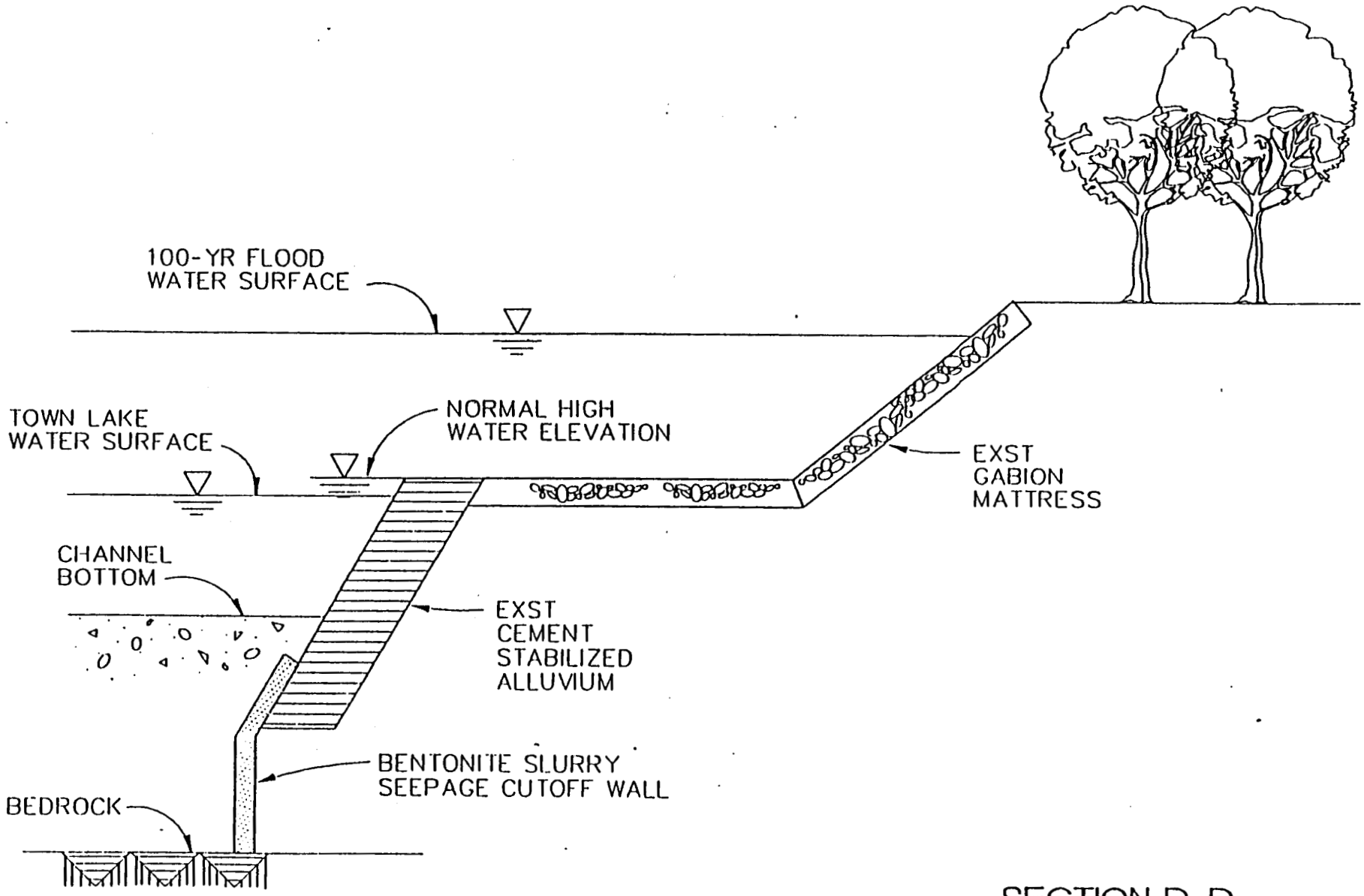
06 17-94



APPL: CITY OF TEMPE
APPL #: 944090400-CL

SHEET 9 OF 10

SECTION D-D

RIO SALADO COE 404
PERMIT APPLICATION

CH2M HILL

D:\USR2\PROJECTS\36963036.DWG

STORM WATER POLLUTION PREVENTION PLAN AND N.P.D.E.S. PERMIT SPECIAL PROVISIONS

This project is subject to National Pollutant Discharge Elimination System (N.P.D.E.S.) requirements under the E.P.A. General Permit for Arizona. Under provisions of that permit, the contractor shall be designated as permittee, and shall be responsible for providing necessary material and for taking appropriate measures to assure removal of at least 80 percent of the additional sediment generated in storm water runoff from the project (relative to pre-project sediment levels), and for completing the following documents:

- Storm Water Pollution Prevention Plan (S.W.P.P.P.) for the project, including certification of compliance form.
- Notice of Intent (N.O.I.) to be covered by N.P.D.E.S. General Permit for Arizona, including certification of signature.
- Notice of Termination (N.O.T.) of coverage under N.P.D.E.S. General Permit (upon project completion).

All subcontractors shall comply with all N.P.D.E.S. requirements under the supervision of the General Contractor, and shall submit a completed, signed subcontractor certification form, thereby designating themselves as co-permittees. A draft framework for the S.W.P.P.P. is enclosed in this Project Specification Book. Contingency bid items likely to be necessary to carry out the S.W.P.P.P. are included in the bid proposal. The contractor will be expected to review this framework S.W.P.P.P. and update/revise it as necessary throughout the construction of the project, in order to assure compliance with the E.P.A. permit requirements. Revisions to the S.W.P.P.P. requiring use of these contingency bid items, or any other additional costs, shall be subject to approval by the City prior to implementation. The finalized S.W.P.P.P. shall be kept on the project site at all times, and shall be retained by permittee for three years following project completion.

The unit prices bid for the proposal items shall include all material, labor, and other incidental costs relating to the provision, installation, and maintenance of that bid item during project construction. Such incidental costs shall include contractor costs in order to assure proper operation of the pollution-control devices installed, including all maintenance, cleaning, and disposal costs associated with clean-up and repair following storm events or other runoff or releases on the project. No additional payment will be made for these incidental costs.

The contractor shall submit completed signed N.O.I. forms prior to the project preconstruction conference to the following addresses: U.S. E.P.A. Storm Water Notice of Intent, P.O. Box 1215, Newington, VA 22122 and ADEQ-Storm Water Coordinator, P.O. Box 600, Phoenix, AZ 85001. Copies shall be transmitted to the City's construction project manager, as provided on the N.O.I. form, at the time of the preconstruction meeting. The Contractor shall prepare a final SWPPP and submit it at the preconstruction meeting for discussion and approval.

Failure by the contractor (or any of its appropriate subcontractors) to submit the N.O.I. forms within this time frame (or to promptly make revisions to those forms as requested by the City) which prevents submittal of the forms to E.P.A. within the mandated deadline of 48 hours prior to start of construction will result in delay of the start of construction. The contractor will not be entitled to any claim for additional compensation for additional costs resulting from such a delay in the construction start date. The N.O.I. shall be posted on the construction site along with the S.W.P.P.P.

It is the permittee's responsibility to perform inspections of all storm water pollution control devices on the project on a monthly basis, and following each rainfall of 0.50 inches or more. The contractor is responsible for maintaining those devices in proper working order, including cleaning and/or repair. No separate payment will be made for such inspections, cleaning, or repair.

All S.W.P.P.P. reports required under this contract shall be available to the public in accordance with the requirements of Section 308 (b) of the Clean Water Act. The contractor as a permittee of construction activities with storm water discharges covered by the Arizona General Permit shall make plans available to the public upon request through the E.P.A.

No condition of the Arizona General Permit as well as the S.W.P.P.P. shall release the contractor from any responsibilities or requirements under other environmental statutes or regulations.

Upon total project completion, acceptance, and de-mobilization, the contractor shall submit its completed, signed N.O.T. form to the E.P.A. Storm Water Notice of Termination, P. O. Box 1185, Newington, VA 22122, with copies to the same agencies who received copies of the N.O.I., thereby terminating all N.P.D.E.S. permit coverage for the project.

Necessary forms for the N.O.I., and the draft S.W.P.P.P. are contained in this booklet. Additional forms will be available through the City's Construction Project Manager and Inspector.

WQMS-301.210-944090400-CL

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Fife Symington, Governor Edward Z. Fox, Director

RECEIVED
MAR 20
REGULATORY BRANCH
FIELD OFFICE

March 13, 1995

Mr. Howard Hargis
City of Tempe
City Engineers Office
P.O.Box 5002
Tempe, AZ 85280

RE: To Construct Rio Salado's Town Lake and Associated Facilities in the Salt River Between Priest Drive and McClintock Drive in the City of Tempe, Maricopa County, Arizona - PUBLIC NOTICE NO. 944090400-CL.

Dear Mr. Hargis:

The Arizona Department of Environmental Quality (ADEQ) staff has reviewed the referenced Public Notice and other information for State Water Quality Certification pursuant to Sections 401 and 404 of the Federal Clean Water Act. Information appearing in Section A describes the project. Information listed in Section B were used as the basis for this State Certification. Our technical review has determined that no negative impacts will occur to the chemical, physical or biological integrity of the Salt River when the Conditions shown below in Section C are adhered to during construction and post construction activities.

A. PROJECT DESCRIPTION

1. The Tempe Town Lake will be formed by the construction of two inflatable dams in the Salt River. A six foot high dam will be placed upstream of the Indian Bend Wash confluence with the Salt River and a 16 foot high dam will be placed ½ mile upstream of Priest Drive. The lake will be two miles long and cover 200 surface acres.

2. Ancillary facilities consist of: boat slips, a City Park, operations building, bike paths, hiking trails, lighting, docks, streets, plantings of trees and shrubs, pump house, public art, water features, parking and picnic areas and other facilities designed to appeal to the public.

B. BASIS FOR CONDITIONAL STATE 401 WATER QUALITY CERTIFICATION

1. State of Arizona, Water Quality Standards for Navigable Waters, Arizona Administrative Code (A.A.C.) Title 18, Chapter 11, Article 1.

2. Arizona Department of Environmental Quality Policy for Protecting Water Quality During Facility Construction, adopted December 21, 1994.

3. Final Report and Recommendations of the Governor's Riparian Habitat Task Force, Executive Order 89-16, dated October 1990, and Executive Order No. 91-6 dated February 14, 1991.

4. A letter dated May 2, 1994 to Ed Swanson from Steve Neilson of the City of Tempe inviting Ed to a Pre-application meeting at the COE office on May 19, 1994.

5. On May 19, 1994 a meeting was held to introduce the Tempe Town Lake project at the COE office in Phoenix. The meeting was attended by representatives of the COE, ADEQ, USFWS, AGF, the City of Tempe and the consultant, CH2M Hill.

6. U.S. Army Corps of Engineers (COE) Public Notice No. 944090400-CL dated September 1, 1994 and received by ADEQ on December 8, 1994.

7. Completed ADEQ form 404-033 dated November 14, 1994 and received by ADEQ on November 16, 1994 from Steve Walker of CH2M Hill (CH2M) including the following items:

   a. Five pages of technical data relating to water quality issues.

   b. A two page report dated September 22, 1994 from George Cotton concerning Salt River Sedimentation.

   c. Twenty 11 X 14 inch drawings of the project.

   d. Eighteen pages of drawings and explanations of the project.

   e. A one page letter dated June 20, 1994 to Steve Neilson from Wayne Palsma concerning the applicability of an NPDES Permit for the Town Lake.

   f. A one page letter dated August 4, 1994 to Steve Neilson from James Du Bois concerning the applicability of an Aquifer Protection Permit.

8. A six page alternatives analysis dated August 30, 1994 to Cindy Lester (COE) from Rich Randall (CH2M).

9. A letter dated December 14, 1994 to Rich Hill (CH2M) from Jim Matt requesting clarification on 14 items concerning the Town Lake.

10. A letter dated January 9, 1995 to James Matt from Steve Walker (CH2M) responding to the December 14, 1994 letter in Item B.9.

11. A letter dated January 12, 1995 from James Matt to Rich Randall requesting clarification on nine items concerning the town lake.

12. A letter dated February 14, 1995 to James Matt from Steve Walker responding to the questions in Item B.11.

13. A meeting at ADEQ on February 27, 1995 attended by Howard Hargis of the City of Tempe, Steve Walker of CH2M Hill and Jim Matt of ADEQ. This meeting was primarily concerned with a discussion of the sampling plan.

14. Letter dated March 13, 1995 from Tom Trent, Clean Lakes Coordinator to Jim Matt discussing the sampling parameters for the Tempe Town Lake.

C. CONDITIONS FOR STATE 401 WATER QUALITY CERTIFICATION

This State Water Quality Certification is issued by the Arizona Department of Environmental Quality under the authority of Section 401(a) of the federal Clean Water Act (33 U.S.C. §1251 *et seq.)*. The conditions listed below apply to this Section 404 Permit issued by the U.S. Army Corps of Engineers. These conditions are enforceable by the U.S. Environmental Protection Agency. Civil penalties up to a maximum of $25,000 per day of violation may be levied if these certification conditions are violated. Criminal penalties may also be levied if a person knowingly violates any provision of the federal Clean Water Act.

1. Other permits or approvals may be required by Maricopa County, the Arizona Department of Environmental Quality (ADEQ), or the U.S. Environmental Protection Agency if the overall project includes a potable water supply, Stormwater management, wastewater reuse facilities, or wastewater collection/holding/treatment/ disposal facilities.

2. No disposal of construction or demolition wastes, wastewater, contaminated water or any other potential pollutant is authorized by this State 401 Water Quality Certification by ADEQ, except as expressly provided in the Section 404 Permit.

3. This Certification is only for the project described in Section A and is valid for a period of 30 months from the date signed by the Director of the Water Quality Division. If project construction has not started by this deadline, the applicant must notify ADEQ, Attention Surface Water Quality Certification, Water Quality Division, 3033 North Central Avenue, 5th Floor, Phoenix, Arizona 85012. ADEQ will then have the option of extending, modifying or denying this Certification.

4. The applicant must provide a copy of these State 401 Water Quality Certification Conditions to all appropriate contractors and subcontractors. The applicant must also post a copy of these conditions in a weather resistant location at the construction site where it may be seen by the workers.

5. There can be no substantive changes/modifications in the project plans and analyses identified in Sections A and B or the implementation of those plans which might affect surface water quality. If a substantive change/modification is desired, notice and supporting information must be submitted to ADEQ for review. ADEQ will then modify this Certification to include the changes/modifications, provided that Water Quality Standards for Navigable Waters (A.A.C. Title 18, Chapter 11, Article 1) will be achieved. Failure of the operator to promptly notify ADEQ of any proposed substantive changes/modifications could result in a revocation of this Certification. Correspondence to ADEQ must be addressed per Condition C.3, above.

6. When this project is physically commenced at the construction site, ADEQ must be notified by the applicant or his designee within seven days of the start date. When this notification is made, please provide the start date and the names and phone numbers of the prime contractor and a contact person. ADEQ may conduct inspections to determine compliance with A.A.C. Title 18, Chapter 11, Article 1. When the project is complete ADEQ must be similarly notified. Notification must be addressed to ADEQ per Condition C.3, above.

7. Runoff and seepage from roadways, embankments, and other alterations of the natural environment must not cause a violation of A.A.C. Title 18, Chapter 11, Article 1.

8. All off-site material sources for the project must have valid and current permits under the Federal Clean Water Act [Sections 402 (NPDES) and 404] and the State Aquifer Protection Program, where necessary. Facilities and activities not covered by individual permits under these programs are not exempt from the duty to comply with water quality standards, and will be subject to compliance action if violation is documented. Other permits pertaining to air quality may be required for material sources and are the responsibility of the applicant or his agent(s).

9. Water for dust suppression, if used, must not contain contaminants that could violate ADEQ water quality standards for surface waters or aquifers.

e. Sampling for Total Petroleum Hydrocarbons (TPH) will be conducted monthly at the same locations as the nutrient and metals samples.

f. Sampling for metals will commence at monthly intervals after the lake has been filled. Metals and nutrients may be sampled at the same time and location. A pattern should soon be apparent and the sampling frequency reduced. The enclosed page titled "Inorganic Chemistry Test Sets" show the list of metals to be sampled for originaly under the column "SURFACE WATER-ALL INORGANICS".

g. An important parameter for judging the health of a lake is the presence of chlorophyll. During the summer months when fecal coloform is being sampled, chlorophyll a, b, c and pheophytin a shall be sampled for at the same time and locations.

This is the initial sampling program for the Tempe Town Lake. Sample results will be sent to ADEQ at the address shown in Item C.3 above. The sampling program will be modified as sample results are received and reviewed. Mr. Howard Hargis, the applicant, will be notified when it is necessary to implement a change in the sample plan.

Construction procedures must be consistent with the Arizona Department of Environmental Quality Policy for Protecting Water Quality During Facility Construction. The specific procedures for preventing water pollution indicated in ADEQ policy statements #1 through #13, together with Conditions C.1 through C.18, listed above, should ensure compliance with water quality standards. Subject to the above Project Description, Basis and Conditions of Certification, this letter certifies that the proposed project of the City of Tempe in the Salt River Channel complies with existing navigable water quality standards. If you have any questions about this Letter of Certification, please call James Matt (602) 207-4502. Thank you for your cooperation and efforts to protect our natural environment.

Sincerely,

Authorized ADEQ Signature _____ Date _____
Kimberly W. MacEachern, Director
Water Division

Enclosuer.

KWM:JRM:jrm

cc: James Romero, EPA Region 9
Corps of Engineers Regulatory Branch - Phoenix
Larry Rielly, AGFD
Sam Spiller, USFWS

INORGANIC CHEMISTRY TEST SETS

	SOW ALL INORGANIC	PRIMARY STANDARDS	SECONDARY STANDARDS	SURFACE WATER-ALL INORGANICS	SURFACE WATER NUTRIENTS	P.P. METALS	DISS. METALS	TOTAL RECOV. METALS	MAJOR CATIONS/ ANIONS
TO USE, CHECK:	ABOVE BLOCKS ONLY					INDIVIDUAL TESTS REQUIRED			
ALKALINITY, TOTAL	X		X	X					X
ALKALINITY, PHENOL	X		X	X					X
AMMONIA					X				
CHLORIDE	X		X	X					X
CONDUCTIVITY	X		X	X					
FLUORIDE	X	X		X					X
HARDNESS	X		X	X					X
NO2 NO3 TOTAL	X	X		X	X				X
NITRITE					X				
PHOSPHORUS					X				
TKN					X				
pH	X		X	X					X
SULFATE	X		X	X					X
TDS	X		X	X					X
TSS				X					
TURBIDITY		X		X					
Ag (Silver)	X	X		X		X	X	X	
As (Arsenic)	X	X		X		X	X	X	
B (Boron)				X					
Ba (Barium)	X	X		X			X	X	
Be (Beryllium)						X			
Cd (Cadmium)	X	X		X		X	X	X	
Ca (Calcium)	X		X	X					X
Cr (Chromium)	X	X		X		X	X	X	
Cu (Copper)	X		X	X		X	X	X	
Fe (Iron)	X		X	X				X	X
K (Potassium)				X					X
Hg (Mercury)	X	X		X		X	X	X	
Mg (Magnesium)	X		X	X					X
Mn (Manganese)	X		X	X				X	
Na (Sodium)	X		X	X					X
Ni (Nickel)						X			
Pb (Lead)	X	X		X		X	X	X	
Se (Selenium)	X	X		X		X	X		
Sb (Antimony)						X			
Tl (Thallium)						X			
Zn (Zinc)	X		X	X		X	X	X	

ARIZONA DEPARTMENT OF WATER RESOURCES

RECOVERY WELL PERMIT

PERMIT NO. 74-547332

STATE OF ARIZONA)
) ss.
County of Maricopa)

This is to certify that I have examined Application No. 74-547332 for a recovery well permit. I have determined that the application meets the requirements of Title 45, Chapter 3.1, Article 3, Arizona Revised Statutes. The Department hereby grants the applicant authority to operate the recovery wells subject to the following limitations and conditions:

Permit Limitations

Applicant: City of Tempe
P.O. Box 5002
Tempe, Arizona 85280

PERMIT 74-547332

Permitted recovery well(s):

Well Registration Number	Location of Well	Design Pump Capacity (GPM)	Well Depth (Feet)	Casing Diameter (Inches)	Maximum Annual Recovery (Acre Feet)
55-551601	SE¼NE¼NE¼ Sec.15 T1N R4E	3200	140	24	51.6
55-551602	SW¼NW¼NW¼ Sec.14 T1N R4E	3200	160	24	51.6
55-551603	SE¼NW¼NW¼ Sec.14 T1N R4E	3200	155	24	51.6
55-551604	NW¼NE¼NW¼ Sec.14 T1N R4E	3200	155	24	51.6
55-551605	NE¼NW¼NE¼ Sec.14 T1N R4E	3200	135	24	51.6
55-551606	NW¼SW¼NE¼ Sec.14 T1N R4E	3200	140	24	51.6
55-551607	NE¼SE¼NW¼ Sec.14 T1N R4E	3200	160	24	51.6
55-551608	SW¼SE¼NW¼ Sec.14 T1N R4E	3200	160	24	51.6
55-551609	SW¼SW¼NW¼ Sec.14 T1N R4E	3200	160	24	51.6
55-551610	SE¼SE¼NE¼ Sec.15 T1N R4E	3200	150	24	51.6

Recovery wells are subject to the operating plans of Facility Permit Numbers 71-516371, 71-551762, and 72-533659, and are subject to the conditions of Water Storage Permit Numbers 73-516371.7000, 73-551761, and 73-533659.

Recovered water will be used for: The beneficial municipal use of the permittee including but not limited to maintaining the Town Lake water levels and/or delivery for uses within the municipal water system.

Legal description of the land on which recovered water will be used: Parts of Sections 14, 15 and 16 of Township 1 North Range 4 East GSRB&M.

PERMIT 74-547332

Permit Conditions

1. In accordance with A.R.S. § 45-875.01.(D), an annual report shall be submitted no later than March 31 following the end of each completed annual reporting permit. The first annual reporting period shall be from the date of this permit through December 31, 1996. Subsequent annual reporting periods shall be January 1 through December 31.

2. The annual report shall include the following information:

   a. The well registration number and location of the wells used to recover stored water.

   b. The quantity of water recovered from each well as measured in a manner consistent with the requirements and specifications for water measuring devices adopted pursuant to A.R.S. § 45-604.

   c. For all stored water recovered each year, report the Water Storage Permit Number(s) from which the water storage originated, the amount of recovery (in acre feet) attributed to each Water Storage Permit, and the source of water originally stored pursuant to each Water Storage Permit.

3. Recovery from each of the Well Registration Numbers referenced above shall not exceed the specified annual volume limit of 51.6 acre feet.

WITNESS my hand and seal of office this 8th day of August, 1996.

Herb Dishlip, Assistant Director

APS
Commitment. Innovation. Energy.

Tel xxx/xxx-xxxx
Fax xxx/xxx-xxxx
e-mail: xxxxxxxx@apsc.com
http://www.apsc.com

Mail Station xxxx
P.O. Box 53933
Phoenix, AZ 85072-3933

August 29, 1996

Mr. Howard Hargis
Assistant City Engineer
City of Tempe
P.O. Box 5002
Tempe, AZ 85280

RE: SOUTH BANK INTERCEPTOR STORMWATER DIVERSION PIPELINE ENCROACHMENT AGREEMENT

Dear Mr. Hargis:

Enclosed is your copy of the fully executed Encroachment Agreement for the above referenced project.

If you have any questions regarding this matter, please call me on 371-7031.

Sincerely,

Barbara H. Cowdery

Barbara H. Cowdery
Land Agent
SI Land Services

Enclosure

AUG 1996
CITY OF TEMPE
ENGINEERING

ENCROACHMENT PERMIT
AND INDEMNIFICATION AGREEMENT

This Encroachment Permit and Indemnification Agreement (the "Agreement") is entered into this 29th day of August, 1996, by and between City of Tempe, an Arizona municipal corporation ("Tempe") and Arizona Public Service Company, an Arizona corporation ("APS").

RECITALS:

A. APS is the owner a Right of Way Easement recorded in Docket 4380, Pages 152-158, and a Utility Easement recorded in Docket 7695, Page 359 Maricopa County Records referred to herein as the ("Easements").

B. APS presently has transmission lines along with appurtenant fixtures and equipment within the Easements (the "Lines").

C. Tempe wishes to encroach upon the Easements by constructing and maintaining the South Bank Interceptor Stormwater Diversion Pipeline within the Easements as shown on Exhibit "A" attached hereto and by this reference incorporated herein (the "Pipeline").

D. APS is willing to allow said encroachment upon the terms and conditions contained herein.

PROMISES AND COVENANTS:

NOW, THEREFORE , in consideration of the foregoing recitals and in further consideration of the following covenants, promises, and provisions, the parties hereby agree as follows:

1. APS hereby authorizes Tempe, at Tempe's sole cost and expense, to install the Pipeline in the locations as shown on Exhibit "A" attached hereto and by this reference incorporated herein.

2. No vehicle over 14 foot in height shall be parked within the Easements for the contractor staging area shown on Dwg. Nos. A-G-6 and A-G-7 attached hereto.

3. No vehicles shall be refueled within the Easements.

4. No flammable or hazardous materials shall be stored within the Easements.

5. Tempe shall obtain independent permission to cross the Easements from the underlying landowner and any other easement holders.

6. Only clean sand and gravel shall be deposited in the designated waste disposal area shown on Dwg. A-G-7 and the material shall be leveled and compacted to avoid restricting APS' access in the Easements. Extreme care must be used when depositing material in the vicinity of tower foundations to avoid damaging these foundations.

7. The final elevation of the waste disposal area shall be no greater than the top of the foundation concrete for the towers located approximately in the center of this area.

8. APS shall not be liable for damage to Tempe's facilities located within the Easements as a result of APS operation and maintenance of the Lines.

9. At all times during the construction and maintenance of the Pipeline within the Easements, Tempe shall comply with all applicable laws, ordinances, rules, regulations, and safety requirements, including but not limited to the Arizona Revised Statutes, the Occupational Safety and Health Standards for General Industry (29 C.F.R. Part 1910), and the National Electrical Safety Code.

10. Tempe shall indemnify, hold harmless, and waive all claims against APS, its employees, agents, and representatives, for any and all claims, demands, suits, losses, costs, and damages of every kind and description, including any attorneys' fees or litigation expenses, on account of loss of, or damage to, any property or for injury to, or death of, any person caused by, arising out of, or contributed to, in whole or in part, by reason of the location, construction, operation, use, maintenance, repair or removal of the Pipeline, or equipment or vehicles within the Easement; provided, however, that this indemnification, waiver and release shall not extend to active negligence or willful misconduct of APS.

11. Tempe further hereby indemnifies APS against loss of revenue if Tempe, its employees, agents, or representatives during construction, maintenance, use, or removal of the Pipe in any way damage the Lines or APS' towers or equipment located within the Easements; provided, however, that this indemnity shall not extend to active negligence or willful misconduct of APS.

12. Tempe acknowledges that APS has provided it with general electric and magnetic field-related information for its consideration and use prior to execution of this Agreement.

13. This Agreement shall not limit or restrict APS' rights granted under the Easement, including the right to add or remove electric facilities in the Easements. Tempe shall not interfere with APS' use of the Easement or APS' business conducted thereon.

IN WITNESS WHEREOF, the parties have executed this Agreement on the day and year first above written.

CITY OF TEMPE

By _____

Its Assistant City Engineer

ARIZONA PUBLIC SERVICE COMPANY
an Arizona corporation

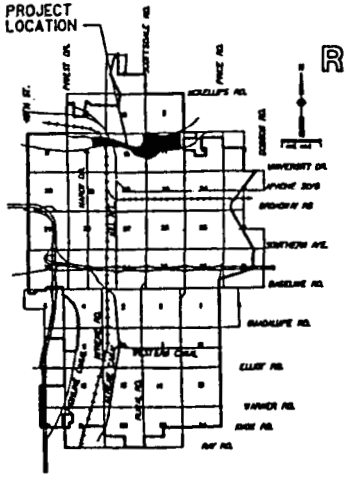
By _____

Its Acting Group Leader

Exhibit "A"

CITY OF TEMPE
PUBLIC WORKS DEPARTMENT
DIVISION OF ENGINEERING

RIO SALADO TOWN LAKE - PROJECT NO. 946523-A
SCHEDULE A - PIPE AND WELL SYSTEMS



MAYOR

NEIL G. GIULIANO

CITY COUNCIL

LINDA SPEARS
DENNIS J. CAHILL
P. BEN ARREDONDO
JOSEPH LEWIS
JOSEPH P. SPRACALE
CAROL E. SMITH

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SHEET INDEX		
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UTILITY INFORMATION

MCI — DATE

AT & T — DATE

US WEST — DATE

ARIZONA PUBLIC SERVICE CO. — DATE

AIR PRODUCTS — DATE

SALT RIVER PROJECT-WATER — DATE

SALT RIVER PROJECT-POWER — DATE

EL PASO NATURAL GAS CO. — DATE

SOUTHWEST GAS CORP. — DATE

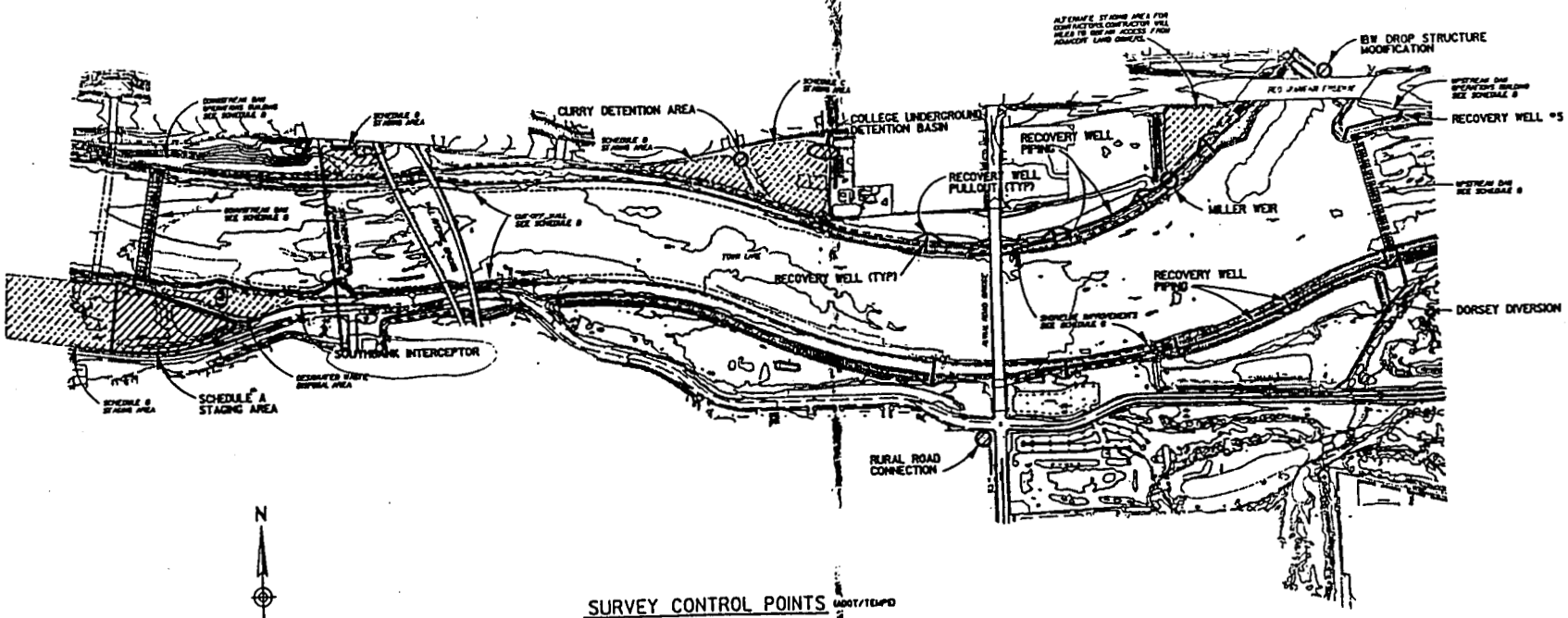
DIMENSION CABLE — DATE

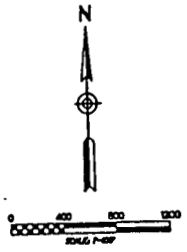
APPROVED

CITY ENGINEER — DATE

DEPT. OF ENVIRONMENTAL MGMT.

3696a001.dgn
4 FEB 1996





SURVEY CONTROL POINTS (ADOT/TEMPE)

NO	N	E	ELEV	DESCRIPTION
174	283837.0774	297359.7527	967.70	B.C. IN HANDWELL AT CONTERLINE SCOTTSDALE RD 200'+ N. INTERSECTION OF 1ST ST (RIM OF HANDWELL PANEL PT)
517	284519.1003	292858.4672	948.72	1/2" REBAR FLUSH W/ GROUND 50'+ OF N. FENCE TEMPE BEACH PARK, 200'+ S. OF OLD MILL BRIDGE
527	286314.7598	294798.2278	965.90	1/2" REBAR FLUSH W/ GROUND IN ACCESS ROAD S. BANK OF IRRIGATION CANAL, NEAR S. BORDER PAPAGO (PARK, (PANEL PT)
1	285893.95	290632.19		1/2" REBAR FLUSH W/ GROUND IN UPPER LEVEE
2	284819.86	290470.18		1/2" REBAR FLUSH W/ GROUND IN UPPER LEVEE
3	286000.00	300250.00		1/2" REBAR FLUSH W/ GROUND IN UPPER LEVEE
4	284887.93	300545.25		1/2" REBAR FLUSH W/ GROUND IN LOWER ACCESS ROAD

ALL COORDINATES SHOWN ARE PROJECT DATUM GROUND COORDINATES

THE COORDINATES ARE REDUCED BY 200,000 IN THE E DIRECTION AND 600,000 IN THE N DIRECTION, FROM ADOT COORDINATES

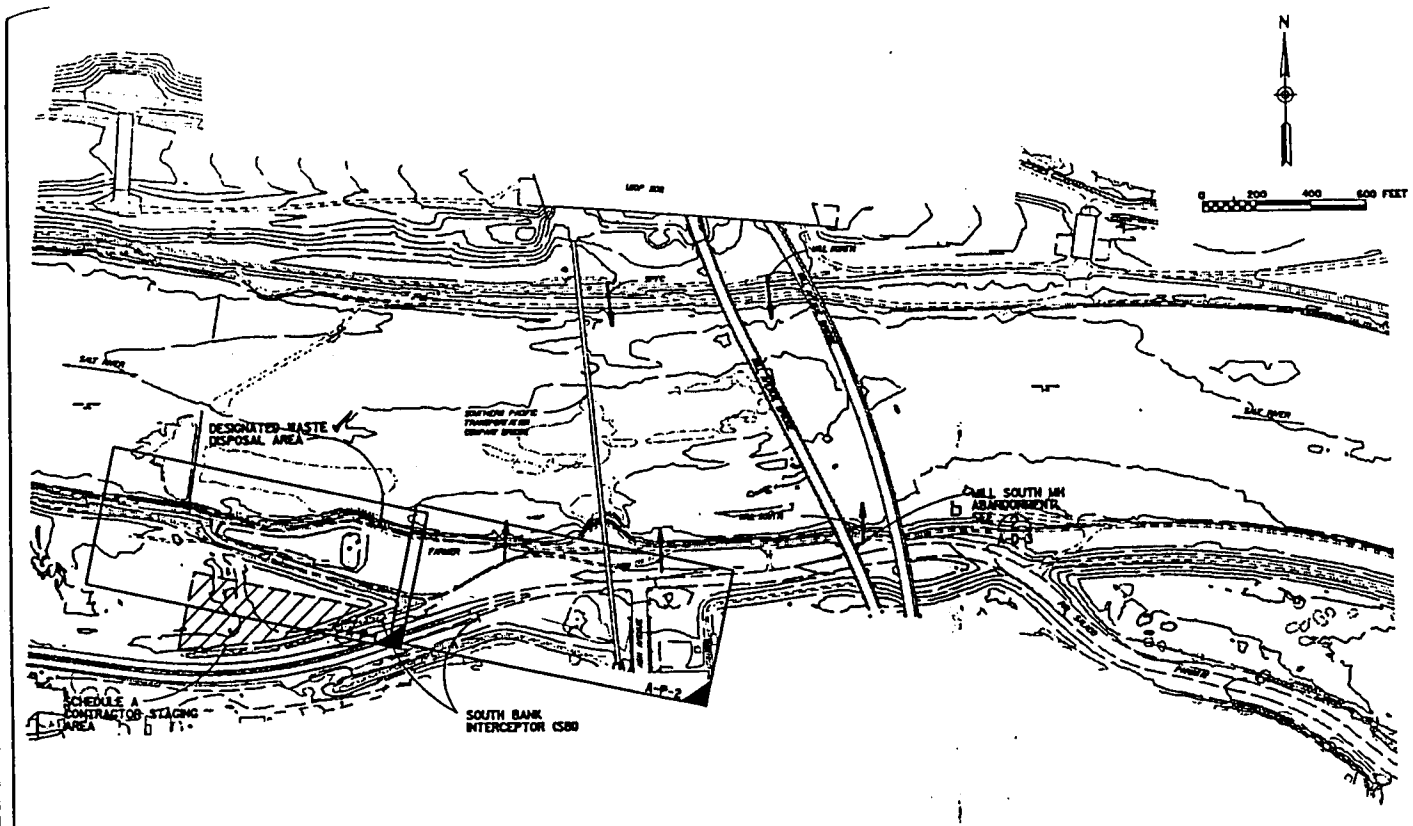
263-1100
CALL BEFORE YOU DIG

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SUBMITTED:	DESCRIPTION: SCHEDULE A GENERAL	DATE: APRIL 1996
DESIGNED:		PROJECT NO. 946523A
DRAWN:	OVERALL PROJECT PLAN	
CHECKED:		SHEET 6 OF 6
SCALE: 1"=400'		DWG. NO. A-C-6

PRELIMINARY 90% REVIEW

3696F02.dgn
02-FEB-1996



LEGEND:

EXISTING STORM DRAINS TO BE MODIFIED, SEE A-O-3

SHEET WINDOW AREA

DRAWING NO.

A-P-3

LOWER RIGHT HAND CORNER

CONSTRUCTION NOTES

263-1100

DEPARTMENT OF PUBLIC WORKS

CITY OF TEMPE

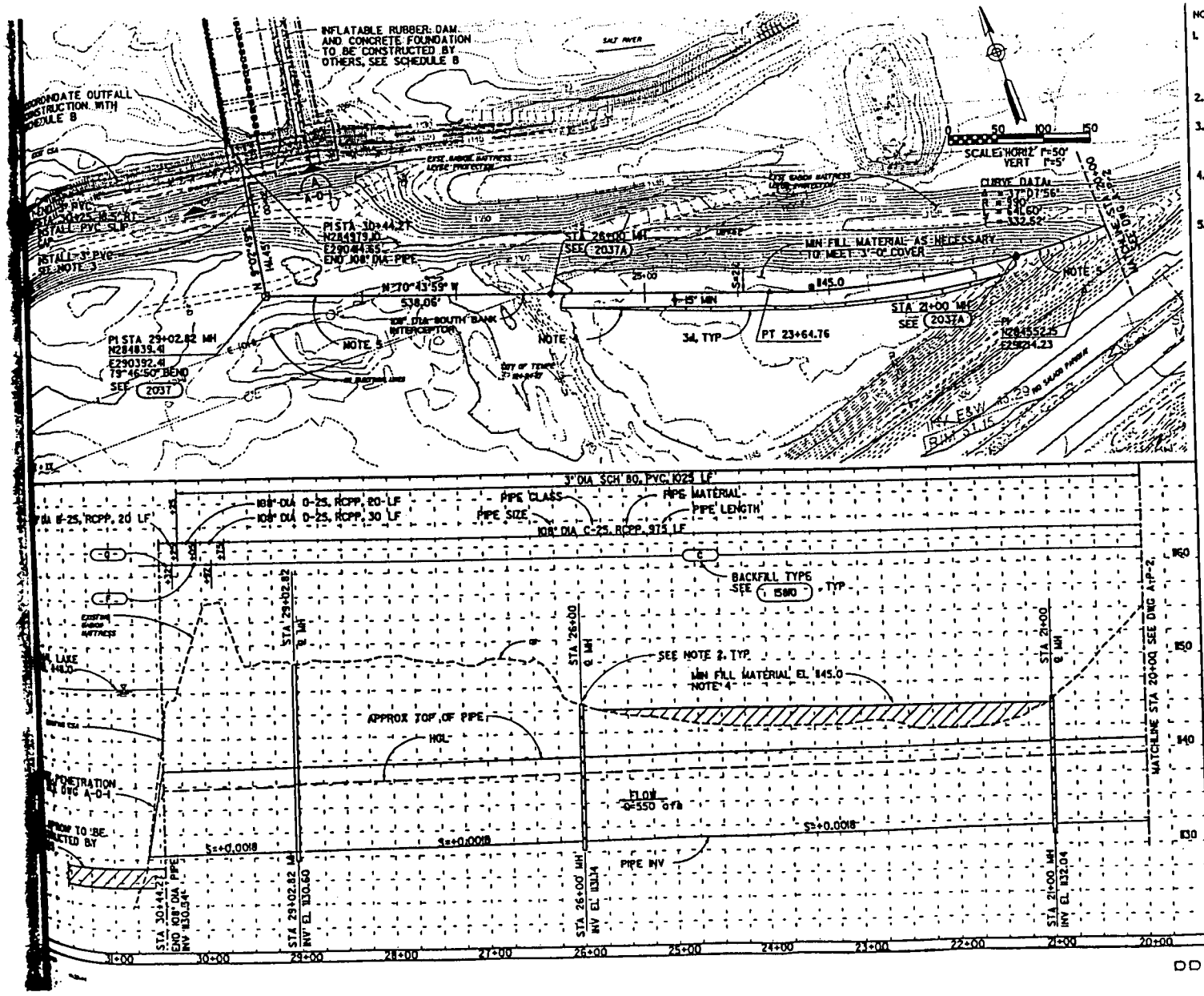
DIVISION OF ENGINEERING

P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION: SCHEDULE A GENERAL	DATE APRIL 1996
DESIGNED: X	STORMWATER DIVERSION PLAN WEST	PROJECT NO. 94S323A
DRAWN: X		SHEET X OF X
CHECKED: X		DWG NO. A-O-7
SCALE: 1"=200'		

PRELIMINARY 90% REVIEW

3496-001.dgn
14-FEB-1996



NOTES:

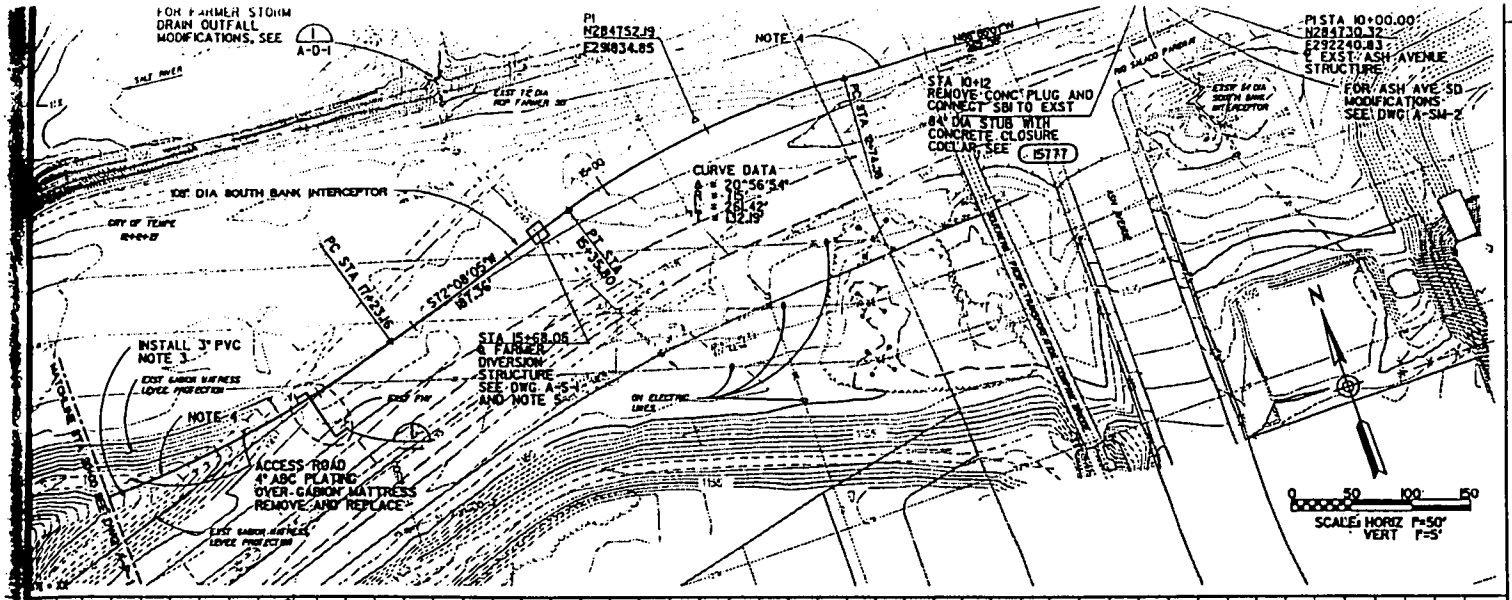
1. EXCAVATE TEST PITS OR BORINGS ALONG CENTERLINE OF SBI ALIGNMENT AT 50' INTERVALS FROM STA 15+50 TO STA 29+00 PRIOR TO EXCAVATING TRENCH. REFER TO SPECIFICATIONS FOR DETAILS OF TEST PIT OR BORING REQUIREMENTS.
2. TOP OF MH RISERS SHALL MATCH THE FINISHED GRADE ALONG THE PIPELINE ALIGNMENT.
3. 3" PVC WATER LINE SHALL BE PLACED IN THE SAME TRENCH AS THE 108" SBI FROM STA 18+10 TO STA 30+25. REFER TO THE PIPE BACKFILL DETAIL ON DWG A-0-8
4. RECENT GRADING ACTIVITIES MAY HAVE ALTERED GROUND SURFACE ELEVATIONS IN THIS AREA. CONTRACTOR SHALL FIELD VERIFY GROUND SURFACE ELEVATIONS.
5. LIMIT EQUIPMENT TRAFFIC OVER NEW PIPELINE FACILITIES TO HS20 LOADS. CONTRACTOR SHALL SUBMIT ACCESS PLANS FOR EQUIPMENT THAT EXCEEDS HS20 LOADS.

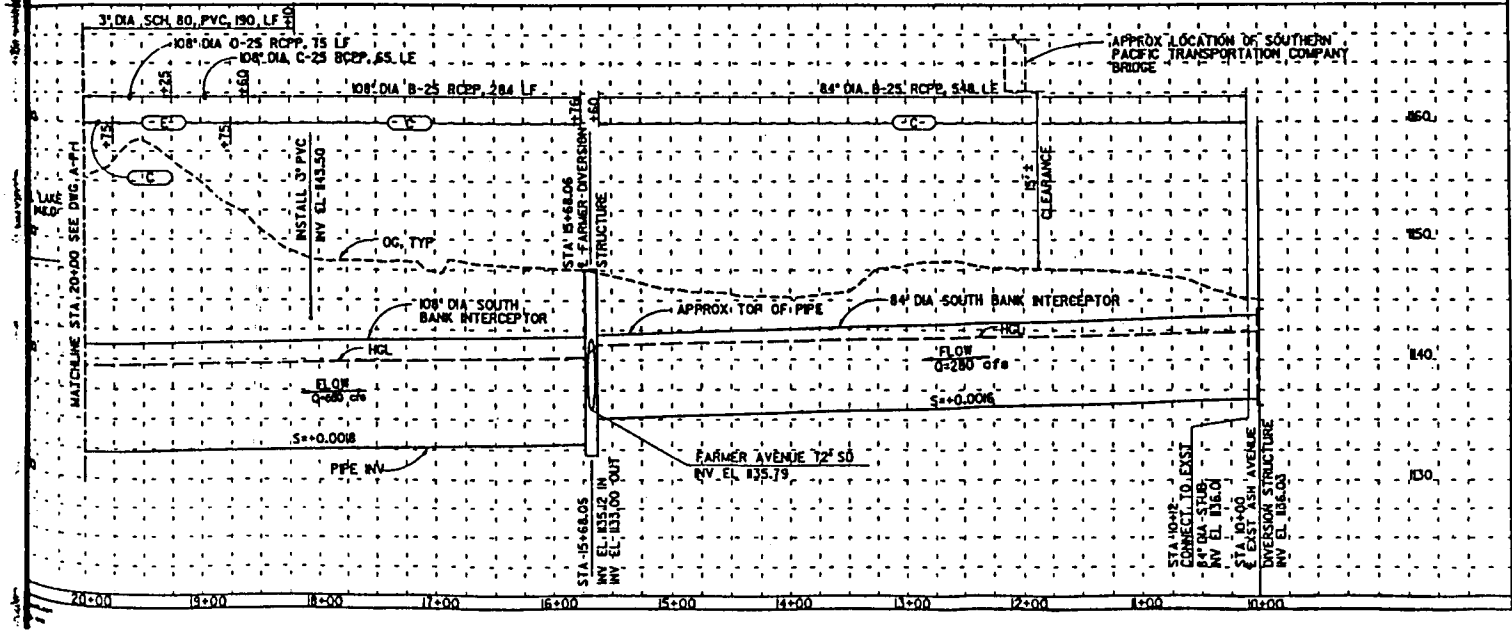
263-1100
CALL BEFORE YOU DIG

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED: X	DESCRIPTION: SCHEDULE A CIVIL	DATE: APRIL 1996
DESIGNED: X	SOUTH BANK INTERCEPTOR PLAN AND PROFILE	PROJECT NO. 946523A
DRAWN:		SHEET X OF X
CHECKED: X		DWG NO. A-P-1
SCALE: 1"=50'		

PRELIMINARY

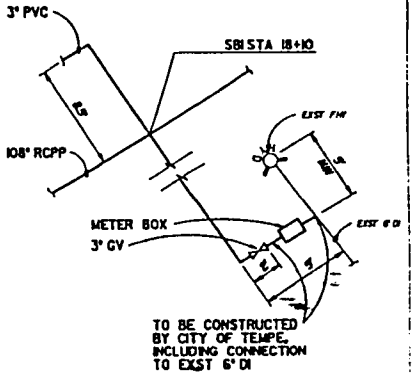




CONSTRUCTION NOTES

NOTES:

1. EXISTING FARMER SD AND ASH AVE SD SHALL REMAIN IN-SERVICE UNTIL SCHEDULES A AND B ARE SUBSTANTIALLY COMPLETE.
2. EXCAVATE TEST PITS OR BORINGS ALONG CENTERLINE OF SBI ALIGNMENT AT 50' INTERVALS FROM STA 15+50 TO STA 29+00 PRIOR TO EXCAVATING TRENCH. REFER TO SPECIFICATIONS FOR DETAILS OF TEST PIT OR BORING REQUIREMENTS.
3. 3" PVC WATER LINE SHALL BE PLACED IN THE SAME TRENCH AS THE 108" SBI FROM STA 18+10 TO STA 30+25. REFER TO THE PIPE BACKFILL DETAIL ON DWG A-D-8.
4. LIMIT EQUIPMENT TRAFFIC OVER NEW PIPELINE FACILITIES TO HS20 LOADS. CONTRACTOR SHALL SUBMIT ACCESS PLANS FOR EQUIPMENT THAT EXCEEDS HS20 LOADS.
5. LOCATION OF EXST 72" SD IS APPROXIMATE BASED ON THE BEST AVAILABLE RECORDS. CONTRACTOR SHALL FIELD VERIFY EXACT LOCATION PRIOR TO MATERIALS PURCHASE.



DETAIL
NTS

263-1100
CALL BEFORE YOU DIG

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA 85280

SURVEYED X	DESCRIPTION SCHEDULE A CIVIL SOUTH BANK INTERCEPTOR PLAN AND PROFILE	DATE APRIL 1996
DESIGNED X		PROJECT NO. 946523A
DRAWN R.E.A.		SHEET X OF X
CHECKED X		DWG NO. A-P-2
SCALE 1"=50'		

P R O P O S A L

Place: Tempe, Arizona

Date: _____

Mayor and City Council
City of Tempe
Tempe, Arizona 85281

In compliance with your invitation for bids and all conditions of the Contract

Documents, the _____,

a corporation organized under the laws of the State of _____,

a partnership consisting of _____,

or individual trading as _____,

of the City of _____, hereby proposes and agrees to furnish any and all plant, materials, labor, construction equipment, service and transportation (all applicable taxes included) of the **RIO SALADO TOWN LAKE DAM FACILITIES SCHEDULE B (PROJECT NO. 946523B)** and to install the material therein for the Owner in a good and workmanlike and substantial manner and to the satisfaction of the Owner, or their properly authorized agents and strictly pursuant to and in conformity with the Contract Documents and other documents that may be made by the Owner or their properly authorized agents, as provided herein, at the following prices:

SCHEDULE B BID LIST

The following are the bid items for Schedule B:

Item	Description	Quan.	Unit	Unit Price	Extended Total Amount
1.	Mobilization/Demobilization for Dam Facilities Work, Demolition, Diversion and Care of Water, and Miscellaneous Items	1	LS	$	$
2.	Downstream Dam Foundation, Piers, Abutments, and Apron	1	LS	$	$
3.	Downstream Dam Operations Building	1	LS	$	$
4.	Installation of OWNER-Furnished Downstream Rubber Dams and Blowers	1	LS	$	$
5.	Submersible Pump and Motor	2	EA	$	$
6.	Upstream Dam Foundation, Piers, Abutments, and Apron	1	LS	$	$
7.	Upstream Dam Operations Building	1	LS	$	$
8.	Installation of OWNER-Furnished Upstream Rubber Dams and Blowers	1	LS	$	$
9.	Union Pacific Railroad Bridge Modifications	1	LS	$	$
10.	Drilling and Grouting	500	SAC	$	$
11.	Removal of Unsuitable Material	50	CY	$	$
12.	4" Electrical Conduit for Primary Service	3,425	LF	$	$
13.	2" Electrical Conduit for Primary Service	1,605	LF		
14.	Installation of 4" Communications Conduits Furnished by Others	2,000	LF	$	$
15.	Transformer Pad	1	EA	$	$
16.	Control Cabinets and Pads	2	EA	$	$
17.	Installation of APS Furnished Pullboxes	2	EA	$	$
18.	Installation of APS Furnished Electrical Box Pads	1	EA	$	$
19.	Coffer Dam Panels and Soldier Piles	1	LS	$	$
Base Bid Extended Total				$	$

Deductive Alternate B1 for Omission of the Upstream Dam Foundation and Apron, the Upstream Rubber Dams and Blowers, and the Upstream Dam Operations Building:

Bidder further proposes that if OWNER elects to omit the construction of the Upstream Rubber Dam Foundation, Piers, Abutments, and Apron, the Upstream Rubber Dams and Blowers, and the Upstream Dam Operations Building as shown on the Drawings, with necessary changes to construction as required to complete the Work with this omission, based on undersigned's own estimate of quantities and cost, the Contract Price will be reduced in the amount of:

_____ Dollars

and _____ Cents $_____

Deductive Alternate B2 for Omission of the Coffer Dam Piling and Steel Panels:

Bidder further proposes that if OWNER elects to omit the construction of the coffer dam piling and steel panels as shown on the Drawings, with necessary changes to construction as required to complete the Work with this omission, based on undersigned's own estimate of quantities and cost, the Contract Price will be reduced in the amount of:

_____ Dollars

and _____ Cents $_____

Proposal - continued

The undersigned hereby declares that he has visited the site and has carefully examined the Contract Documents related to the work covered by the above bid.

The Undersigned understands that the City of Tempe reserves the right to award a contract or to reject all bids and to waive any informalities in any bid, deemed to be in the best interests of the City.

"NOTICE: THIS CONTRACT CONTAINS AN EXCLUSIVE AND MANDATORY PARTNERING AND AN ALTERNATIVE DISPUTE RESOLUTION PROCESS FOR THE EFFICIENT AND EXPEDITIOUS RESOLUTION OF ALL CLAIMS WHICH MAY ARISE FROM THIS CONTRACT AND OTHER CONTRACTS CONTAINING THESE PROVISIONS FOR THE PROJECT."

Performance shall not start until after receiving the Notice to Proceed, and the Project will be completed within four-hundred six (406) consecutive calendar days after receiving the Notice to Proceed.

The Undersigned hereby acknowledges receipt of the following Addenda:

_____ and his bid has been adjusted to reflect any changes.

Respectfully submitted,

_____
(Name) (Signature)

_____
(Title)

_____
Contractor's License No.

_____
Federal I.D. No./Social Security No.

ATTEST:

_____
(Name)

_____
(Title)

_____
Witness: If Bidder is an Individual

(Corporate Seal)

_____
(Company Name)

Address:_____

_____

Phone: _____

BIDDERS PROJECT REFERENCES

All bidders shall list at least three (3) projects, if possible, similar in scope to this project, that they have completed. Show references in the space provided below (or attached separate sheet):

Job Title/Description	Contracting Agency	Phone No./Contact Person

LIST OF SUBCONTRACTORS

In accordance with the provisions of Section 108.2 of the "Maricopa Association of Governments Uniform Standard Specifications for Public Works Construction", the bidder shall provide the information listed below regarding proposed subcontractors. Failure to provide complete and accurate information may disqualify the bid.

Subcontractor Name	Subcontractor Address	Type of Work	% of Total Contract

CONTRACT

THIS AGREEMENT, made and entered into this _____ day of _____, 1996, by and between the City of Tempe, a Municipal Corporation, organized and existing under and by virtue of the laws of the State of Arizona, party of the First Part, hereinafter designated the **OWNER**, and_____, of the City of _____ County of _____, and State of _____, party of the Second Part, hereinafter designated as the **CONTRACTOR**:

WITNESSETH: That said Contractor, for and in consideration of the sum to be paid him by said Owner, in the manner, amount and at the time hereinafter provided in the "Proposal" and of the other covenants and agreements herein contained, and under the penalties expressed in the bonds hereto attached, hereby agrees, for himself, his heirs, administrators, successors, and assigns as follows:

ARTICLE I - SCOPE OF THE WORK: The Contractor shall furnish any and all plant, materials, labor, construction equipment, services and transportation (all applicable taxes included) required for performing all work for the installation of the

RIO SALADO TOWN LAKE DAM FACILITIES SCHEDULE B
PROJECT NO. 946523B

for the sum of _____ ($_____), and to construct the same and install the material therein for the Owner, in a good and workmanlike and substantial manner and to the satisfaction of the Owner or his properly authorized agents and strictly pursuant to and in conformity with the Specifications and Plans for the above referenced project(s) and other documents that may be made by the Owner through the Engineer or his properly authorized agents, as provided herein.

ARTICLE II - CONTRACT DOCUMENTS: The "Notice to Contractor", "Special Provisions", "Maricopa Association of Governments Uniform Standard Specifications and Details for Public Works Construction", as amended by the City of Tempe, "Proposal", "Plans", together with "Bid Security", "Performance Bonds", "Payment Bond", and Addenda thereto, if any.

ARTICLE III - TIME OF COMPLETION: The Contractor further covenants and agrees at his own proper cost and expense, to do all work and furnish all plant, materials, labor, construction equipment, services and transportation for performing all of the work for the construction of said improvements and to construct the same and install the material therein, as called for by this Agreement free and clear in all claims, liens, and charges whatsoever, in the manner and under the conditions specified within the time stated in the Proposal.

IN WITNESS WHEREOF, three (3) identical counterparts of this Contract, each of which shall be for all purposes, be deemed an original thereof, have been duly executed by the parties hereinabove named, on the date and year first herein written.

CITY OF TEMPE
a Municipal Corporation

_____
Name

_____
Title

ATTEST:

_____
Authorized Officer

_____
Official Title

(Corporate Seal)

APPROVED AS TO FORM:

_____
City Attorney

CONTRACTOR:

_____
Party of the Second Part

_____
Name

_____
Title

City of Tempe Transaction Privilege
License Permit No.

_____

ATTEST:

(Corporate Seal)

_____
Name

_____
Title

_____
Witness: If Contractor is an Individual

STATUTORY PERFORMANCE BOND PURSUANT TO TITLE 34,
CHAPTER 2, ARTICLE 2, OF THE ARIZONA REVISED STATUTES
(Penalty of this bond must be 100% of the Contract amount)

KNOW ALL MEN BY THESE PRESENTS:

That, _____(hereinafter called the Principal), as Principal and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____, (hereinafter called the Surety), are held and firmly bound unto _____ (hereinafter called the Obligee) in the amount of _____ Dollars ($_____), for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written contract with the Obligee, dated the _____ day of _____, 19___, to complete Project No. 946523B which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall faithfully perform and fulfill all the undertakings, covenants, terms, conditions and agreements of said contract during the original term of said contract and any extension thereof, with or without notice to the Surety, and during the life of any guaranty required under the contract, and shall also perform and fulfill all the undertakings, covenants, terms, conditions, and agreements of any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the Surety being hereby waived; then the above obligation shall be void, otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Title 34, Chapter 2, Article 2, of the Arizona Revised Statutes, and all liabilities on this bond shall be determined in accordance with the provisions of said Title, Chapter and Article, to the extent as if it were copied at length herein.

The prevailing party or any party which recovers judgment on this bond shall be entitled to such reasonable attorney's fees as may be fixed by the Court or a judge thereof.

Witness our hands this _____ day of _____, 19 _____.

_____

PRINCIPAL SEAL

BY:_____

**

_____

SURETY SEAL

BY:_____

_____

AGENCY ADDRESS

Surety hereby acknowledges they are licensed to do business in the State of Arizona

STATUTORY PAYMENT BOND PURSUANT TO TITLE 34,
CHAPTER 2, ARTICLE 2, OF THE ARIZONA REVISED STATUTES
(Penalty of this bond must be 100% of the Contract amount)

KNOW ALL MEN BY THESE PRESENTS:

That, _____(hereinafter called the Principal), as Principal and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____, (hereinafter called the Surety), as held and firmly bound unto_____ (hereinafter called the Obligee) in the amount of _____ Dollars ($_____), for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written contract with the Obligee, dated the _____ day of _____, 19___, to complete Project No. 946523B which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall promptly pay all moneys due to all persons supplying labor of materials to him or his subcontractors in the prosecution of the work provided for in said contract, then this obligation shall be void, otherwise to remain in full force and effect;

PROVIDED, HOWEVER, that this bond having been required of the said Principal in order to comply with the provision of Title 34, Chapter 2, Article 2, of the Arizona Revised Statutes, all rights and remedies on this bond shall inure solely to such persons and shall be determined in accordance with the provisions, conditions and limitations of said Title, Chapter and Article, to the same extent as if it were copied at length herein.

The prevailing party or any party which recovers judgment on this bond shall be entitled to such reasonable attorney's fees as may be fixed by the Court or a judge thereof.

Witness our hands this _____ day of _____, 19 _____.

_____
PRINCIPAL SEAL

BY:_____

**_____
SURETY SEAL

BY:_____

_____
AGENCY ADDRESS

Surety hereby acknowledges they are licensed to do business in the State of Arizona

CITY OF TEMPE

CERTIFICATE OF INSURANCE

CITY OF TEMPE PROJECT NO. 946523B

The _____ certifies that the listed insurance policies have been issued on behalf of

Name of Insured: _____
Address of Insured: _____

It is further certified that the **City of Tempe** has been named as additional insured as is required under said contract and that the independent contractor's insurance is primary as to any claims resulting from the contract.

Required Insurance	Company(s) Name	Policy Number	Expiration Date	Minimum Limits Required
WORKERS COMPENSATION				Statutory
GENERAL LIABILITY:				
Comprehensive Form				$5,000,000.00 per occurrence Bodily Injury
Premises/ Operations				$1,000,000.00 per occurrence Property Damage
Products/ Completed Operations				
Contractual				
Broad Form Property Damage				
Independent Contractors				
AUTOMOBILE LIABILITY:				
Owned/Non-Owned				Same as above
PROPERTY COVERAGE				See below

When the project includes construction of a new or modification of an existing building, property insurance shall be secured covering **Fire, Extended Coverage and Vandalism and Malicious Mischief** in an amount equal to the Contract amount less costs for any foundation, underground utilities and/or landscaping. The **CITY OF TEMPE** shall be named as additional insured.

Liability Policy Includes Coverage for:

1) A. Damage caused by blasting.
   B. Damaged caused by collapse or structural injury.
   C. Damage to underground utilities.

2) Liability assumed in construction agreements and other types of contracts or agreements in effect in connection with insured operations.

3) All owned, hired or non-owned automotive equipment used in connection with the insured operation.

_____It is agreed that none of these policies will be canceled or changed so as to affect this certificate until ten (10) days after written notice of such cancellation or change has been delivered to the **City of Tempe**.

It is further agreed that:

1) These policies shall not expire until all work has been completed and the project has been accepted by the **City of Tempe**. (If a policy does expire during the life of the **Contract**, a renewal **Certificate** of the required coverage must be sent to the **City of Tempe** not less than five (5) days prior to expiration date.)

This certificate is not valid unless countersigned by an authorized representative of the **Insurance Company**.

DATE: _____ COUNTERSIGNED BY _____

NAME

_____

SIGNATURE

_____

ADDRESS

_____

TELEPHONE NUMBER

CITY OF TEMPE
TEMPE, ARIZONA
DEPARTMENT OF PUBLIC WORKS

CONTRACTOR'S AFFIDAVIT
REGARDING
SETTLEMENT OF CLAIMS

_____, Arizona

Date _____

PROJECT: **RIO SALADO TOWN LAKE DAM FACILITIES SCHEDULE B, PROJECT NO. 946523B**

To the City of Tempe, Arizona

Gentlemen:

This is to certify that all lawful claims for materials, rental of equipment and labor used in connection with the construction of the above project, whether by subcontractor or claimant in person, have been duly discharged.

The undersigned, for the consideration of $_____, as set out in the final pay estimate, as full and complete payment under the terms of the contract, hereby waives and relinquishes any and all further claims or right of lien under, in connection with, or as a result of the above described project against the City of Tempe. The undersigned further agrees to indemnify and save harmless the City of Tempe against any and all liens, claims of liens, suits, actions, damages, charges and expenses whatsoever, which said City may suffer arising out of the failure of the undersigned to pay for all labor performances and materials furnished for the performance of said installation.

Signed and dated at _____, this _____ day of _____, 19____.

_____
Contractor

By:_____

STATE OF ARIZONA)
) SS
COUNTY OF MARICOPA)

The foregoing instrument was subscribed and sworn to me before this _____ day of _____, 19_____.

_____
Notary Public

_____
My Commission Expires