



STATE OF HAWAII
DEPARTMENT OF HAWAIIAN HOME LANDS
91-5420 Kapolei Parkway,
Kapolei, HI. 96707

TECHNICAL SPECIFICATIONS

FOR
FURNISHING LABOR AND MATERIALS FOR

Kau Water System Improvements – Phase 1
Kamaoa, Kau, Island of Hawaii, Hawaii

TMK: (3) 9-3-001:002; (3) 9-3-002:005, 030; (3) 9-3-003:013, 025

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DIVISION 2 – CIVIL WORK

SECTION 02010 – GENERAL REQUIREMENTS FOR CIVIL WORK

PART 1 – GENERAL

1.01 GENERAL CONDITIONS

The General Provisions and Special Provisions in these specifications shall govern all work specified hereinafter in all DIVISIONS and SECTIONS.

1.02 DIVISION OF WORK

The Divisions and Sections into which these specifications are divided shall not be considered an accurate or complete segregation of work by trades. This also applies to all work specified within each section.

1.03 SCOPE OF WORK

The work required to be performed by the Contractor consists of constructing and completing the project “Kau Water System Improvements” at the Department of Hawaiian Home Lands at Kau, in accordance with the Drawings and Specifications and all applicable provisions of the Contract Documents.

1.04 DRAWINGS

- A. The location, extent and design of the required construction and improvements are shown and noted on the Drawings accompanying these Specifications, which Drawings are hereby made a part of these Specifications and the Contract. A complete list of Drawings and Titles is given on the Title Sheet of the Drawings.
- B. Where “as shown”, “as indicated”, “as noted”, “as detailed”, “as scheduled”, or words of like meaning are used in these Contract Documents, it shall be understood that the reference to the foregoing Drawings is being made, unless otherwise specified.
- C. When reference to the work “plans” is made anywhere in the Contract Documents, it shall be understood that such reference refers to the Drawings.

1.05 SPECIFICATION LANGUAGE

These Specifications are written in imperative and abbreviated form. This imperative language of the technical sections is directed at the Contractor, unless specifically noted otherwise. Incomplete sentences shall be completed by inserting “shall”, “the Contractor shall”, and “shall be”, and similar mandatory phrases by inference in the same manner as they are applied to notes on the drawings. The words “shall be” shall be supplied by inference where a colon (:) is used within sentences or phrases. Except as worded to the contrary, fulfill (perform) all indicated requirements whether stated imperatively or otherwise.

1.06 SUBSTITUTION OF MATERIALS AND EQUIPMENT

- A. Request for substitution shall be submitted within the time designated in the SPECIAL PROVISIONS.
- B. All submittals, excepting for samples and documents requiring original signature, shall be e-mailed to Sara T. Okuda at the Department of Hawaiian Home Lands Office at E-Mail: sara.t.okuda@hawaii.gov. The "Subject of e-mail request shall begin with the IFB number. Samples and documents requiring original signature shall be mailed or delivered to the Land Development Division Office, Department of Hawaiian Home Lands, 91-5420 Kapolei Parkway, Kapolei, HI 96707.
- C. E-mailed request shall be submitted together with electronic technical brochures and be accompanied by a statement of variances as shown on the attached "Sample Request for Substitution." Only "Request for Substitution" using the attached sample format will be considered.

The statement of variances shall list all features of the proposed substitution which differ from the plans, specifications and/or product(s) specified and shall further certify that the substitute has no other variant features. The brochures shall be clearly marked showing make, model, size, options, etc., and shall include sufficient evidence to enable the Department to evaluate each feature listed as a variance. All submittal with insufficient information for evaluation shall be rejected. Should an unlisted variance be discovered after installation of the product, the penalty shall be immediate replacement with the original specified item at no cost to the Department.

If sufficient evidence from which a determination can be made for a particular model does not accompany a request for substitution, the request shall be denied. The decision of the Department will be final.

- D. When submitting request for substitutions, if the Contractor elects to use materials and/or equipment other than those shown on the plans and/or specifications, the Contractor shall be responsible to revise existing conditions and to coordinate work with other trades as many be necessary because of the substituted product. Any additional cost to implement such a change shall be borne by the Contractor at no cost to the Department.
- E. Bidders are cautioned to review the Technical Specifications carefully and thoroughly. Objections to or request for clarification of the specifications shall be made in writing to Sara T. Okuda at the Department of Hawaiian Home Lands Office at E-Mail: sara.t.okuda@hawaii.gov, no later than fourteen (14) consecutive calendar days prior to the scheduled bid opening date. The submittal of a bid shall be considered as acceptance of the specifications as published. The "Subject of e-mail request shall begin with the IFB number. Protest concerning the Technical Specifications lodged after bid opening shall not be considered.

1.07 PATENTED DEVICES, MATERIALS AND PROCESSES: If the Contractor is required or desires to use any design, device, material or process covered by letters of patent or copyright, the right for such use shall be processed by the Contractor from the patentee or owner. The Contractor and Surety shall indemnify and hold harmless the State and its Departments and Agencies, and affected third party, Designer of Record (Architect/Engineer), or political subdivision from any and all claims for infringement by reason of the trademark or copyright in connection with the work to be performed under the contract, shall indemnify the State and its Department and Agencies, and Designer of Record (Architect/Engineer) for any costs, expenses and damages which it may be obligated to pay by reason of any infringement at any time during the prosecution of after the completion of the work.

1.08 DESCRIPTION OF BID ITEM

The work includes all labor, materials, tools, equipment necessary to complete the construction of the water system improvements at the location shown on the plans. Major work items include clearing and grubbing at the reservoir site and water filling station, 0.10-million gallon reservoir, grading, A.C. paving, facility piping, drainage improvements, electrical work, including deductive bid items concerning the four PRV stations, and incidental related work.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

S A M P L E

Date: _____

Department of Hawaiian Home Lands
Land Development Division
91-5420 Kapolei Parkway
Kapolei, Hawaii 96707
E-Mail: sara.t.okuda@hawaii.gov

To Whom It May Concern:

Subject: REQUEST FOR SUBSTITUTION

Project Title: _____

In accordance with the GENERAL REQUIREMENTS, I hereby submit for substitution with the technical brochures and statement of variances for your review and approval for the item(s) shown below:

<u>SECTION/SPECIFIED ITEM</u>	<u>SUBSTITUTE OR ALTERNATE BRAND</u>	<u>VARIANT ^{3/} FEATURES</u>
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I further certify that my request for substitution of the above item(s) has no other variant features and complies with the plans and specifications for subject project.

SIGNATURE

- NOTE: 1. Please use own letterhead.
2. Submit by E-Mail: sara.t.okuda@hawaii.gov
3. If no variant feature, then indicate "None."

END OF SECTION

SECTION 02050 –DEMOLITION AND REMOVAL WORK

PART 1 – GENERAL

1.01 GENERAL CONDITIONS

As specified in Section 02010.

1.02 PERMIT AND FEES

The Contractor shall obtain and pay for all necessary permits for removal work prior to commencement of work.

1.03 WORK DESCRIPTION

The work to be performed under this section shall include the furnishing of all labor, tools, equipment and incidentals necessary to perform all demolition and removal work indicated on the drawings or required for the reception of the new construction specified. This includes, but is not limited to, demolition and removal of existing sidewalk, curb, gutter, guardrail, signs, drainage structures, and pavements, and demolition and removal required for any adjustment, extension or protection of existing utilities.

1.04 JOB CONDITIONS

- A. Condition of Existing Improvements: The Department assumes no responsibility for the actual condition of items or portions of structures to be removed.
- B. Interference with Adjacent Occupied Spaces: Maintain free and safe passage to and from occupied spaces. Provide temporary barricades and other forms of protection as required to protect the general public from injury due to demolition and/or removal work.
- C. Storage or sale of removed items on site will not be permitted.
- D. Protection: Provide temporary barricades and other forms of protection as required to protect the general public from injury due to selective removal work and to maintain security.
 - 1. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or elements to be removed, and adjacent facilities or work to remain.

2. Protect from damage existing finish work that is to remain in place and becomes exposed during demolition operations.
 3. Life safety procedures and provisions shall be in conformance with all applicable Federal, State, and City and County regulations, including OSHA.
- E. Damages: Promptly repair damages caused to adjacent facilities or areas by removal work at no cost to the Department.
- F. Traffic: Conduct demolition operations and debris removal in a manner to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close, block or otherwise obstruct streets, walks or other occupied or used facilities without written permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
- G. Use of explosives will not be permitted.
- H. Dust and Erosion Control: Contractor shall comply with requirements set forth in Section 01567 – POLLUTION CONTROL.

PART 2 – PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 CONSTRUCTION REQUIREMENTS

The Contractor shall exercise every precaution to preserve and protect existing improvements to remain or to be removed by others.

3.02 EXISTING UTILITY LINES

- A. The existence of underground utility lines other than those shown is not definitely known. The Contractor shall be responsible for toning, probing, obtaining as-built drawings, etc., to determine existing utility locations prior to any demolition work. The Contractor shall promptly repair all damaged utilities at no cost to the Department.
- B. The Contractor shall serve proper notice and consult with the Engineer regarding any temporary disconnections of electrical or other utility lines in the area which may be required for the removal

work, and all such lines where necessary shall be properly disconnected before commencing with the work.

3.03 DEMOLITION

- A. All work shall be executed as indicated on the plans, with due consideration for all items to remain.
- B. Limits of asphalt concrete pavement removal shall be as shown on the plans or as directed by the Engineer. Saw cut along the excavation line to provide clean and straight joint lines.
- C. If required, removal of existing signs includes foundations below grade.
- D. Any open trenches, holes, depressions and pits left open at the end of the working day shall be covered by steel plates.
- E. If unanticipated mechanical, electrical or structural elements which conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report to Engineer in written, accurate detail. Pending receipt of directive from Engineer rearrange selective demolition schedule as necessary to continue overall job progress without delay.

3.04 DISPOSITION OF MATERIAL

- A. All materials resulting from removal work, except as indicated or specified otherwise, shall become the property of the Contractor and shall be removed from the limits of Department property. Remove rubbish and debris from the jobsite daily, unless otherwise directed; do not allow accumulations inside or outside any buildings or roadways. The Contractor shall transport and legally dispose of materials off site. Remove and transport debris and rubbish in a manner that will prevent spillage on streets or adjacent areas.
- B. If hazardous materials are encountered during demolition operations, comply with applicable State, Federal and local regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
- C. Burning of removed materials is not permitted on project site.

3.05 CLEAN-UP AND REPAIR

- A. Any disturbance to road beds, landscaped areas, brick pavers, etc., shall be restored to original condition. The Contractor shall take care to avoid damage to immediate and surrounding areas and protect property and vehicles.
- B. In landscaped areas, remove grass in a manner that will allow replacement close to its original condition. Use a drop cloth or similar ground cover at all times to contain and hold removal of earth and plantings, whether on concrete, asphalt, lawn, and/or landscaped areas.
- C. Any concrete, asphalt, or brick pavers removed shall be replaced in as close to original condition as possible, and within the limits of generally accepted trade standards. When regrassing is required, the grass used shall match the surrounding area.
- D. Damage resulting from removal work shall be repaired by the Contractor at his/her expense. The condition of all existing exposed surfaces shall be equal to or better than that which existed before the removal work. Where the method of repair work is not indicated or specified, the Contractor shall perform the repair work in accordance with the limits of generally accepted trade standards.

END OF SECTION

SECTION 02110 – CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

As specified in Section 02010.

1.02 WORK DESCRIPTION

The work covered in this section shall consist of furnishing all labor, materials, equipment, tools and incidentals necessary for clearing and grubbing as shown on the plans and specified herein.

1.03 PERMITS AND FEES

The Contractor shall obtain and pay for all necessary permits required to perform this work.

PART 2 – PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 PROTECTION OF ITEMS TO REMAIN

The Contractor shall continually maintain adequate protection of trees, shrubbery, topographic features and all other items indicated to remain.

3.02 CLEARING AND GRUBBING

- A. The overall limits of the clearing and grubbing, as shown on the plans, shall be staked prior to construction.
- B. The Contractor shall clear the area within the grading limits of all vegetative material and obstructions necessary for the proper reception, construction, execution and completion of other work specified in this contract. Vegetative material includes trees, logs, stumps, roots of downed trees, brush, grass and weeds. Obstructions include buildings, lumber, fences, trash piles and other unwanted materials.
- C. Within the grading limits and where indicated on the drawings, grub the entire ground surface of all grass, weeds, stumps, roots and other objectionable materials down to at least 12 inches below the existing ground surface.
- D. No excavation or filling shall be undertaken until area has been cleared and grubbed.

- E. The Contractor shall protect from injury and damage all surrounding plants, pavements, buildings, utilities, etc., and shall leave all in as good a condition as at present. Any damage to existing improvements shall be repaired or replaced by the Contractor to the satisfaction of the Engineer.

3.03 DISPOSITION OF MATERIAL

- A. All materials resulting from the clearing and grubbing work, shall be removed from the limits of Department property. Remove rubbish and debris from the jobsite daily, unless otherwise directed; do not allow accumulations inside or outside any buildings or roadways. The Contractor shall transport and legally dispose of materials off site. Remove and transport debris and rubbish in a manner that will prevent spillage on streets or adjacent areas.
- B. If hazardous materials are encountered during the clearing and grubbing operations, comply with applicable State, Federal and local regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
- C. Burning of removed materials is not permitted on the project site.

3.04 INSPECTION AND APPROVAL

Prior to the construction of any new work, the Engineer shall inspect the area that has been cleared and grubbed. The Contractor shall not proceed until the clearing and grubbing work has been approved by the Engineer. Should the Contractor install any new work without the Engineer's approval, the Engineer may require the Contractor to remove the installed work for inspection and reconstruct at no additional cost to the Department.

END OF SECTION

SECTION 02200 – EARTHWORK

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

As specified in Section 02010.

1.02 WORK DESCRIPTION

Furnish all labor, materials, tools, and equipment necessary for site excavation, trench excavation, structural excavation, filling, backfilling, rough and finish grading, and related items necessary to complete all work shown on the Drawings and/or specified herein.

1.03 STANDARDS

Work shall be in accordance with the “Standard Specifications for Public Works Construction”, dated 1986 as amended, and the “Water System Standards”, dated 2002 as amended, except as shown in the plans and specifications herewith. (Paragraphs concerning Measurement and Payment in the Sections are not applicable to this project.)

1.04 COORDINATION WITH OTHER SECTIONS

- A. Demolition and removal as specified in Section 02050 - DEMOLITION AND REMOVAL WORK.
- B. Clearing and grubbing as specified in Section 02110 - CLEARING AND GRUBBING.

1.05 ORDINANCES AND PERMITS

- A. The Contractor shall comply with all applicable ordinances and regulations and obtain the required permits. All grading work shall comply with Chapter 10 of the Hawaii County Code, as amended.
- B. The Contractor shall comply with the provisions of Chapter 11-55 Water Pollution Control and Chapter 11-54 Water Quality Standards of the Hawaii Administrative Rules, Department of Health, State of Hawaii.

1.06 EXISTING UTILITY LINES

The existence of active underground utility lines within the construction area is not definitely known other than those indicated in their approximate

locations on the Drawings. Should any unknown line be encountered during excavation, the Contractor shall immediately notify the Department of such discovery. The Department shall then investigate and issue instructions for the preservation or disposition of the unknown line. Authorization for extra work shall be issued by the Department only as it is deemed necessary.

1.07 LAYOUT OF PROJECT

The Contractor shall verify all lines, levels, elevations and improvements indicated on the drawings before any excavation begins. All lines and grades shall be verified by a Surveyor or Civil Engineer licensed in the State of Hawaii. Any discrepancy shall be immediately brought to the attention of the Department and any change shall be made in accordance with his instruction. Commencement of clearing and grubbing operations shall be construed to mean that the Contractor agrees that the existing grades and improvements are essentially correct as shown. The Contractor shall not be entitled to extra payment if existing grades and improvements are in error after his verification thereof, or if he fails to report the discrepancies before proceeding with any work whether within the area affected or not.

1.08 SUBMITTALS

- A. Soil Testing Lab Accreditation: The Contractor shall retain and pay for an independent soil testing laboratory with at least one Licensed Civil Engineer specializing in Geotechnical Engineering to provide monitoring and testing services. The soil testing laboratory shall be accredited by the American Association of State Highway and Transportation Officials (AASHTO) or the American Association for Laboratory Accreditation and shall be accredited in the soils tests required under this contract. The soil testing laboratory shall meet the requirements of ASTM D 3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as used in Engineering Design and Construction.

The Contractor shall furnish to the Department for approval, a copy of the Certificate of Accreditation and Scope of Accreditation and latest directory of the accrediting organization for accredited laboratories. The scope of the laboratory's accreditation shall include the test methods required by the Contract.

The Contractor shall submit certified test results to the Department for review and approval. All test results must be approved before

the Contractor can proceed with placing subsequent layers or materials.

Should imported fill be utilized on this project, a sample of the proposed material should be submitted to the independent soil testing laboratory for testing. A letter from the testing laboratory stating that the imported material meets the requirements of this section shall be submitted to the Department prior to delivery of the material to the job site.

- B. Field density tests shall be taken to determine whether the specified levels of compaction are being consistently attained. Testing shall be done as indicated.
 - 1. Sub-grade for Asphalt Concrete Pavements: Testing shall be as specified in Section 02510 - ASPHALTIC CONCRETE PAVEMENT.
 - 2. Structural and Yard Fill: One (1) compaction test for every 1500 square feet of each lift.
 - 3. Trench Backfill: One (1) Compaction test per lift for every 200 lineal feet with a minimum of one (1) test per lift for each line.
- C. The Contractor shall have the following documents available for the use of the Department's inspector at the job site:
 - 1. Grading Ordinance (Chapter 10 of the Hawaii County Code).
 - 2. Hawaii Administrative Rules, Chapter 11-55 Water Pollution Control and Chapter 11-54 Water Quality Standards, Department of Health, State of Hawaii.
 - 3. ASTM D1557.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Fill and Backfill Material
 - 1. Yard fill: Yard fill shall be used for all areas where no concrete slabs or A.C. pavements are to be constructed. Fill materials shall be non-expansive soil, free from debris, perishable or combustible materials, sod, and stones larger

than 6 inches in maximum dimension and shall have a plasticity index not greater than 20. Any rock shall be well distributed in earth or other fine material with all voids filled and shall not be placed within 3 feet of the finished grade.

The excavated basalt rock fragments may be reused in compacted yard fills provided the material is crushed to a relatively well-graded consistency and rock fragments larger than 6-inch in diameter are removed. Occasional 12-inch size fragments may be allowed provided the boulders are not nested together forming voids between rock fragments. For the upper 3 feet of fill, the compacted fill should consist of 3-inch minus material.

In the event that insufficient amount of yard fill is delivered from earthwork operations, the Contractor shall import the necessary materials without any additional cost to the Department. Such imported materials shall be subject to approval by the Department and shall meet the requirements as specified for yard fill.

2. Structural fill: Structural fill shall be used in areas where new concrete or A.C. paving is to be constructed and shall be non-expansive, granular, well-graded material with a 3 inch maximum particle size and less than 20 percent by weight passing the No. 200 sieve. The fill material shall be free from clumps of soil, organic debris, adobe or other deleterious matter.

The plasticity index for that portion of soil passing the #40 sieve shall not be greater than 10. The CBR expansion value shall be no greater than 1%. Recycled asphalt pavement shall not be used as structural fill.

The excavated basalt rock fragments may be reused in compacted structural fills provided the material is crushed to a relatively well-graded consistency and rock fragments larger than 3-inch in diameter are removed. For the upper 3 feet of fill, the compacted fill should consist of 3-inch minus material.

3. Trench and Structure Backfill: Backfill shall conform to the requirements of the "Standard Specifications for Public Works Construction", Department of Public Works, County of Hawaii, September 1986".
 4. Cushion material for drain pipes and structures shall be #67 Crushed Rock (ASTM C-33 Size No. 67), unless otherwise shown.
 5. Cushion material for ductile iron water lines shall be 1-1/2" basecourse.
- B. Temporary perimeter control shall have the following properties:
1. Compost Filter Sock: Compost filter sock shall utilize an outer layer of filtration mesh, and an inner layer of containment netting. All layers shall collectively enclose the compost filtration media. Compost filter sock shall be installed as 12" nominal diameter as indicated on the project drawings, or as approved by the Department. Compost filter socks shall be BioSock™ as manufactured by EnviroTech BioSolutions, or approved equal.
 2. Compost Filtration Media: Compost quality is an important consideration when designing a compost filter sock. Use of sanitized, mature compost will ensure that the compost filter sock performs as designed and has no identifiable feedstock constituents or offensive odors. The compost used in filter socks should meet all local, state, and Federal quality requirements. Biosolids compost must meet the Standards for Class A biosolids outlined in 40 Code of Federal Regulations (CFR) Part 503.
 3. Wood Anchor Stakes: Wood anchor stakes shall have a nominal classification of ¾ by ¾ inch and minimum length of 16 inches. Larger sized wood anchor stakes may be installed at the discretion of the installer, or as specified by the Project Engineer. Do not use rebar or other metal rods. Where ground is rocky, use gravel bags to hold filter sock in place.

PART 3 - EXECUTION

3.01 GENERAL

- A. No excavation or filling shall be undertaken until the area has been cleared and grubbed.
- B. Install temporary perimeter control where shown on the drawing or ordered by the Department. Remove perimeter control upon completion of permanent BMP controls.
- C. All excavation shall be protected and guarded against danger to life, limb and property.
- D. Shoring, cribbing and lagging, as required to safely preserve the excavations and earth banks from damages resulting from the work, shall be provided and installed by the Contractor.
- E. The Contractor shall at all times control the grading around building areas so that the ground is adequately sloped to prevent any water from flowing into building areas and open trench excavations. All excavations shall be kept free from standing water. The Contractor shall do all pumping and draining that may be necessary to remove water to the extent required in carrying on the work. The Contractor shall obtain the National Pollutant Discharge Elimination System (NPDES) permit from the State Department of Health for any dewatering activities.

Lowering or raising of water table in areas where ground settlement or other detrimental effects may be induced is expressly prohibited. In such areas, the excavated spaces shall be sealed prior to the pumping of water or other approved means employed by the Contractor. The Contractor shall be responsible for disposal of the pumped liquids. Water from dewatering and other construction operations shall not be discharged directly into the storm drainage system. The method of discharge shall comply with Department of Health Regulations.

Construction equipment which require water in their operation shall not be used in the vicinity or within the building area without the approval of the Department.

- F. Caution shall be exercised in all excavation work adjacent to existing trees which are to remain. All exposed fibrous and branch-type roots shall be carefully pruned or saw-cut to the extent required for excavation work. Every effort shall be taken to preserve the existing trees designated to remain and to minimize damage to said trees.

- G. The Contractor shall use the best management practices to reduce the amount of soil erosion resulting from the grading work. Requirements of the National Pollutant Discharge Elimination System (NPDES) Permit, site specific Best Management Plan (BMP) shall become part of these specifications by reference.

The work areas and haul roads, including roadways leading to the project site, shall be continuously watered to prevent the generation of dust. Granular materials shall be spread over all unpaved haul routes. An 8-inch thick layer of #2 crushed rock shall be installed at delivery access points to reduce tracking mud onto public roadways.

All truck tires shall be free of mud before leaving the job site and entering a public roadway. The Contractor will clean all roads of mud and dirt resulting from his operations at no additional cost to the Department.

- H. Landscaped areas shall be graded to conform to finish contours with allowance for the specified depth of topsoil, except at cut slopes 1 horizontal to 1 vertical or steeper.

I. Laying Out

1. The laying out of base lines, establishment of grades and staking out the entire work shall be done by a surveyor or a civil engineer licensed in the State of Hawaii, at the Contractor's expense. The Contractor shall be solely responsible for their accuracy. The Contractor shall erect and maintain substantial batterboards showing construction of lines and levels.
2. Should any discrepancies be discovered in the dimensions given in the plans, the Contractor shall immediately notify the Department before proceeding any further with the work. The Contractor shall be responsible for re-establishing property corners or survey control points which are destroyed by his operations.

3.02 EXCAVATION

A. General Requirements

1. Excavation shall be done so as to obtain the elevations called for on Drawings, allowing for fill, grading, topsoil and

drainage away from buildings. Provide new swales as indicated.

2. The Contractor shall check electrical drawings for excavation of electrical trenches.
3. Usable Materials as approved by the Department shall be stockpiled (for later use as fill material) in a location approved by the Department. Crushing basalt fragments may be necessary prior to reuse in compacted fills.
4. Non-usable Material such as mud, soft material, and expansive soils and excess materials shall become the property of the Contractor and shall be disposed of outside the project boundary limits at locations that have been approved by the County of Hawaii.
5. Blasting as a means of excavation shall not be permitted.
6. Unsuitable subgrade soil, as determined by the Department, shall be excavated and removed by the Contractor.

B. Structural Excavation

1. Unless otherwise shown, all footings shall be founded on 12 inches minimum of compacted structural fill. In cut areas, the existing basalt rock shall be over-excavated to allow for the 12-inch fill layer.
2. Excavation for footings and foundation shall have level beds, with stepped levels where necessary; localized soft spots shall be over-excavated and removed and the resulting void backfilled with approved structural fill properly compacted in accordance with these specifications.
3. Trenching for foundation footings and grade beams shall be made to the depth and dimensions called for on the Drawings. Bottom of trenches shall be level, solid and free from loose material. All foundation and footings must be carried to the depth shown on the plans. Over-excavation shall be corrected as specified, for which no extra compensation will be allowed.
4. When suitable bearing for foundations is not encountered at the elevation indicated on Drawings, the Contractor shall immediately notify the Department and shall not proceed any

further until the necessary instructions for resumption of work have been received.

5. Lava tubes and cavities may be encountered during excavation. Contractor shall inform the Department immediately of each discovery and work shall be done in accordance with his instructions.

C. Trench Excavation

1. The Contractor shall do all necessary trench excavation to the depth required by the plans, including the excavation for pipe cushion. The excavation shall be unclassified and shall be performed regardless of the material encountered.
2. The minimum width of the trench at the top of the pipe, when placed, shall be a width which will permit the proper construction of joints and compaction of backfill around the pipe. The sides of the trench shall be vertical, unless otherwise approved by the Department. The maximum allowable width of the trench from the bottom of the excavation to a height of 12 inches above the pipe shall not exceed 12 inches on each side of the pipe when placed, unless otherwise approved by the Department.
3. When unsuitable material is encountered at the excavation, the Contractor shall be responsible for hauling and disposing of the material. The hauling and disposing shall be considered incidental to the excavation work. The Department shall determine if the excavation material is unsuitable.
4. The Contractor shall properly sheet and brace all trenches and excavations to render it safe and secure from possible slides and erosion. Sheet piling and bracing of trenches shall be considered as incidental to the excavation work.
5. All trenches shall be kept free from surface run-off and any water during the trenching and installation, testing and backfilling of pipe. Discharge from dewatering operations shall not be drained directly onto any roadway or into any drainage system. The Contractor shall obtain the National Pollutant Discharge Elimination System (NPDES) permit from the State Department of Health for any dewatering activities.

6. All open trenches shall be covered or barricaded during non-working hours. Traffic bearing covers shall be provided where applicable. No open trenches shall be allowed within the South Point Road roadway during non-working hours.
7. All excavated material shall be piled or stored so that it does not obstruct vehicular traffic or pedestrian walkways.

3.03 FILL AND BACKFILL

A. General Requirements

1. Filling operations shall be performed so as to bring the entire project area to the finished grades shown on the Drawings, allowing for topsoil, concrete slab, or A.C. paving and base course.
2. At the time of compaction, the moisture content of fill and backfill material shall be such that the relative compactions specified can be obtained with the compacting equipment being used. At all times, it shall be the responsibility of the Contractor to employ such means as may be necessary to obtain a uniform optimum moisture content throughout the material being compacted.
3. Soft or loose soils that do not readily compact should be excavated and replaced with compacted structural fill at no cost to the Department.
4. All areas to receive fill shall be scarified, moisture conditioned to near optimum moisture content and compacted to a minimum of 95 percent relative compaction as determined by ASTM D1557 for a minimum depth of eight (8) inches.
5. In areas with gravelly material, the exposed gravelly material should be scarified to a depth of 6 inches and recompact to a minimum of 95 percent compaction, as determined by ASTM D 1557, prior to placement of the fill.
6. All fill slopes shall be at 2:1 or flatter as shown on plans. Fill slopes exceeding 15 feet in height shall include benches a minimum of 8 feet in width with the benches constructed at intervals not exceeding 15 feet in vertical height.

7. Fill placed in areas which existing slopes are steeper than 5:1 (horizontal to vertical) shall be continually benched as the fill is brought up in lifts.

B. Yard Fill

Yard fill shall be placed in layers, 8 inches or less in loose thickness, and compacted to 95 percent of maximum density as determined by the ASTM D1557 procedure. Yard fill using 6-inch minus material shall be compacted as approved by the Geotechnical Engineer.

C. Structural Fill for Pavement Areas

Structural fill shall be placed in layers, 8 inches or less in loose thickness, moisture conditioned to near optimum moisture content, and compacted to at least 95 percent of maximum density as determined by ASTM D1557 procedure.

D. Trench Backfill

1. Bottom of Excavation to Midpoint of Pipe

All trenches and excavations shall be backfilled within a reasonable time after the pipes are installed. The backfill material from the bottom of the excavation to the midpoint of the pipe shall be pipe cushion material. The backfill shall be placed in loose layers not to exceed 6 inches in depth along each side of the pipe and shall be compacted. Special care shall be taken to secure thorough compaction under the haunches and at the sides of the pipe and to insure that the backfill material is in continuous and uniform contact with the pipe. Backfilling shall be done in a manner which avoids causing any movement of the pipe sections.

2. Midpoint of Pipe to 6 Inches Above Pipe

- a) For corrugated polyethylene pipe, the backfill material shall be pipe cushion material.

- b) The backfill shall be placed in loose layers not to exceed 6 inches in depth along each side of the pipe and compacted with hand or pneumatic tampers. The backfill shall be brought up evenly on each side of the pipe to an elevation of 6 inches over the top of the pipe, or such elevation as directed by the Department. Backfilling shall be done in a manner which avoids causing any movement of the pipe sections.

2. From 6 Inches Above Pipe to Surface

Backfill from 6 inches above the pipe barrel to finished grade shall be native material which contains less than 50 percent rock or hard lumps of earth. The greatest dimensions of rock or earth lumps permitted shall be 6 inches. Adobe, expansive soils or other unsuitable or deleterious materials shall not be used for backfill. For roadway areas, the upper 2 feet of the trench backfill shall be compacted to 95 percent of its maximum density and shall meet the requirements of the roadway pavement structure.

3.04 FINISH GRADING

Outdoor areas not covered by pavement or other finish surfaces shall be graded to finish grade and contours, with an allowance for gravel as shown on the plans or topsoil as specified.

3.05 TOPSOIL

Topsoil shall be placed as specified. The Contractor shall deposit and spread a layer of topsoil at all areas other than A.C. paved or concrete slab areas as shown on the drawings. The topsoil shall be lightly compacted to the finish elevations shown on the Drawings. The topsoil shall meet the requirements as defined in Section 02920 – LAWNS AND GRASS.

3.06 CLEAN UP

Clean up and remove all debris accumulated from construction operations from time to time, when and as directed by the Department. Upon completion of the construction work and before final acceptance of the work, remove all surplus materials, equipment, etc., and leave entire job site clean and neat.

END OF SECTION

SECTION 02362 - SOIL TREATMENT FOR VEGETATION CONTROL

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

As specified in Section 02010.

1.02 GENERAL REQUIREMENTS

This work shall consist of applying weed killer on all graded areas prior to placement of any fill material, topsoil, or aggregate base courses and to treat existing pavements prior to resurfacing work.

1.03 SUBMITTALS

Prior to the start of work, the Contractor shall submit to the Department the material product data and Material Safety Data Sheets for the material proposed for use.

PART 2 - PRODUCTS

2.01 MATERIALS

Weed Killer shall be "Casoron 10G", "Casoron 4G", or "Norosac 4G", for under asphalt application on new or rebuilt pavement, and shall be "Hyvar X", "Roundup" or "Glyphosate" for application to existing weeds for resurfacing jobs.

PART 3 - EXECUTION

3.01 APPLICATION

The weed killer shall be mixed and uniformly spread using calibrated application equipment at the maximum rates permitted and in strict accordance with the manufacturer's label.

Nut grass shall be retreated two (2) days after initial application and again if growth still exists.

The Contractor shall notify the Department one week before application of weed killer.

END OF SECTION

SECTION 02510 – ASPHALTIC CONCRETE PAVEMENT

PART 1 – GENERAL

1.01 GENERAL CONDITIONS

As specified in Section 02010.

1.02 GENERAL REQUIREMENTS

Sections 29, 30, 31, 33, and 34 of the “Standard Specifications for Public Works Construction” County of Hawaii, Department of Public Works, September 1986, as amended, is hereby incorporated into and made part of these specifications by reference unless otherwise modified hereinafter with the exception of paragraphs “Method of Measurement” and “Basis of Payment.”

Sections 304, 305, 306, 312, and 401 of the “Hawaii Standard Specifications for Road and Bridge Construction, 2005”, Department of Transportation, Highways Division, as amended, is hereby incorporated into and made part of these specifications by reference unless otherwise modified hereinafter with the exception of paragraphs “Method of Measurement” and “Basis of Payment.”

1.03 WORK DESCRIPTION

The work to be performed under this section shall consist of furnishing all labor, materials, equipment, tools and incidentals necessary to construct complete in place asphalt concrete pavements and trench restoration of existing asphalt concrete pavements in accordance with the contract drawings.

1.04 COORDINATION WITH OTHER SECTIONS

- A. Earthwork is specified in Section 02200 - EARTHWORK.
- B. Soil treatment is specified in Section 02362 – SOIL TREATMENT FOR VEGETATION CONTROL.

1.05 SUBMITTALS

- A. The Contractor shall furnish to the Engineer the affidavits and data from the supplier for the following:
 - 1. Design Mix for asphalt concrete pavement.

2. Base Course Material.
3. Sub-base Course Material.
4. Untreated Permeable Base Course Material.

B. Testing laboratory accreditation data.

1.06 SAMPLING AND TESTING

- A. The Contractor shall retain and pay for an independent soil testing laboratory with at least one Licensed Civil Engineer specializing in Geotechnical Engineering to provide monitoring and testing services. The soil testing laboratory shall be accredited by the American Association of State Highway and Transportation Officials (AASHTO) or the American Association for Laboratory Accreditation, and shall be accredited in the tests required under this contract. The soil testing laboratory shall meet the requirements of ASTM D 3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as used in Engineering Design and Construction.

The Contractor shall furnish to the Department for approval, a copy of the Certificate of Accreditation and Scope of Accreditation and latest directory of the accrediting organization for accredited laboratories. The scope of the laboratory's accreditation shall include the test methods required by the Contract.

The Contractor shall submit certified test results to the Department in accordance with Section 01300 - SUBMITTALS. All test results must be approved before the Contractor can proceed with placing subsequent layers or material.

- B. Density tests shall be taken to determine whether the specified levels of compaction are being consistently attained. Testing shall be done as indicated.
1. Sub-Grade: One (1) Compaction test per lift for every 5,000 square feet of prepared subgrade where basalt rock is not exposed.
 2. Aggregate Base: One (1) compaction test per lift for every 2,500 square feet of aggregate base.

3. Aggregate Sub-Base: One (1) compaction test per lift for every 2,500 square feet of aggregate sub-base.
- C. Compaction and thickness testing for asphaltic concrete paving shall be performed at a rate of one (1) test per lift every 500 lineal feet of roadway. Sampling shall be as specified in Section 34 the "Standard Specifications for Public Works Construction", County of Hawaii, Department of Public Works, September 1986.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Materials shall conform to the below-listed sections of the "Standard Specifications for Public Works Construction", County of Hawaii, Department of Public Works, September 1986 except as amended in the plans and/or specifications herewith. (Paragraphs concerning Measurements and Payments in the Sections are not applicable to this project.)

- | | | |
|----|----------------------------------|------------|
| 1. | Subgrade | Section 29 |
| 2. | Select Borrow for Subbase Course | Section 30 |
| 3. | Base Course | Section 31 |
| 4. | Prime Coat for Pavement | Section 33 |
| 5. | Tack Coat for Pavement | Section 33 |
| 6. | Asphalt Concrete Pavement | Section 34 |

- B. Materials shall conform to the below-listed sections of the "Standard Specifications for Road and Bridge Construction", State of Hawaii, 2005 except as amended in the plans and/or specifications herewith. (Paragraphs concerning Measurements and Payments in the Sections are not applicable to this project.)

- | | | |
|----|---------------------------------|-------------|
| 1. | Aggregate Base Course | Section 304 |
| 2. | Aggregate Subbase Course | Section 305 |
| 3. | Untreated Permeable Base Course | Section 306 |
| 4. | Hot Mix Asphalt Pavement | Section 401 |

- C. Aggregate Base Course shall have a minimum CBR value of 85.

PART 3 – EXECUTION

3.01 NEW PAVEMENT CONSTRUCTION

- A. Asphalt concrete shall be as indicated on the plans and shall be constructed in accordance with Section 34 of the “Standard Specifications for Public Works Construction”, County of Hawaii, Department of Public Works (DPW), September 1986. Aggregate base and sub-base courses shall be compacted to a minimum 95% compaction as determined by ASTM D1557, and constructed in accordance to Section 31 and 30, respectively, of the DPW Standard Specifications.
- B. Demolition and removal of existing pavement is indicated on the plans and specified in Section 02050 - DEMOLITION AND REMOVAL.
- C. Prior to placement of the base course, the subgrade shall be scarified to a depth of about eight (8) inches, moisture conditioned to above the optimum moisture content, and recompact to a minimum of 95 percent relative compaction. In areas where dense clinker materials or basalt rock formations are exposed, the subgrade should be proof-rolled with a minimum 10-ton vibratory roller or similar heavy equipment for a minimum of six passes to help detect and collapse near surface cavities in lieu of scarification and compaction.
1. Prime coat shall be applied as specified in Section 33 of the “Standard Specifications for Public Works Construction”, County of Hawaii, Department of Public Works, September 1986.

3.02 TRENCH RESTORATION OF EXISTING PAVEMENTS

- A. Trench restoration of existing pavements within the South Point Road shall be as specified on the plans and in Section 11 and Section 38 of the “Standard Specifications for Public Works Construction”, County of Hawaii, Department of Public Works, September 1986.

3.03 CLEAN UP AND REPAIR

- A. Any existing asphaltic concrete pavements including roads and walkways that have been damaged by construction activities shall

be repaired to the original condition and to the satisfaction of the Department. Damage done by the heavy equipment, especially on roads not stable for such equipment, shall be repaired to the original condition and to the satisfaction of the Department. Concrete curbs and sidewalks that have been cracked or damaged by the Contractor's equipment or delivery trucks shall be reconstructed.

- B. Repair work may consist of asphalt concrete resurfacing, scarifying and removing the existing pavement and reconstructing a new pavement of equivalent thickness, and reconstruction of concrete curbs and sidewalks.

END OF SECTION

SECTION 02665 – WATER SYSTEM

PART 1 – GENERAL

1.01 GENERAL CONDITIONS

As specified in Section 02010.

1.02 GENERAL REQUIREMENTS

A. The following construction standards, with certain modifications as hereinafter specified, are hereby incorporated into and made a part of these specifications by reference and shall be applicable to all work performed by the Contractor under this section.

1. "Water System Standards", dated 2002 of the Department of Water Supply, County of Hawaii, as amended. Paragraphs relating to Measurement and Payment in the Sections are not applicable to the project.
2. Specific sections of the "Standard Specifications for Public Works Construction", Department of Public Works, County of Hawaii, September 1986 (hereinafter referred to as "DPW Standard Specifications") as amended, with deletion of subsections relating to measurement and payment in all sections incorporated herein and further modifications to such sections as hereinafter provided.
3. Specific sections of the "Hawaii Standard Specifications for Road and Bridge Construction, 2005", Department of Transportation, Highways Division, as amended and as it pertains to construction within the South Point Road right-of-way, is hereby incorporated into and made part of these specifications. Paragraphs relating to Measurement and Payment in the Sections are not applicable to the project.

1.03 WORK DESCRIPTION

The work to be performed under this section shall consist of furnishing all labor, materials, equipment, tools and incidentals necessary to install exterior water system as indicated on the Plans and specified herein.

1.04 SUBMITTALS

A. Certificates:

1. The Contractor shall furnish to the Department affidavits and descriptive literature from the manufacturers of pipe, pipe coating, fittings, valves, cast iron castings, backflow preventer, pressure regulating valve and other appurtenances furnished and installed under this section certifying that such materials delivered to the project conform to the requirements of this section. Certificate of disinfection shall also be submitted to the Department.
- B. Shop Drawings:
1. Submit shop drawings for:
 - a. Meter Boxes
 - b. Meter Box Covers
- C. The Contractor shall have the following documents available for the use of the State's inspector at the jobsite:
1. Water System Standards, dated 2002 of the Department of Water Supply, County of Hawaii, as amended.
 2. AWWA Standard C600.
 3. AWWA Standard C651.

1.05 COORDINATION WITH OTHER SECTIONS

- A. Trench Excavation and Backfill specified in Section 02200-EARTHWORK.
- B. Concrete work is specified in Section 03300 - CAST-IN-PLACE CONCRETE.

1.06 DEPARTMENT OF WATER SUPPLY CHARGES

- A. The Department of Water Supply "Water System Facilities Charges", if any, shall be paid directly to the Department of Water Supply by the Owner.
- B. The Contractor shall pay for all charges for the water meter and inspection by the Department of Water Supply.

1.07 EMERGENCY NOTIFICATIONS

- A. The Contractor shall notify the Department of Water Supply and the Department of all water system shut downs 2 weeks in advance.
- B. In addition, the Contractor shall notify the Fire Department 72 hours in advance if any fire hydrant is to be shut off.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. All materials shall be in accordance with the appropriate sections of Division 200 of the Water System Standards as listed below. All materials specified herein and as specified in the Water System Standards that are in contact with potable water shall be lead free in accordance with the Reduction of Lead in Drinking Water Act.

:

1. Ductile Iron Pipe, Fittings and Special Castings..... Section 202
2. Valves and Appurtenances..... Section 205
3. Meter Box and Valve Box Covers and FramesSection 207
4. Service Lateral and Appurtenances..... Section 208
5. Pre-Molded Filler, Crushed Rock, Pipe Cushion, Backfill Material and Bricks Section 209
6. Brass Products..... Section 211
7. Miscellaneous..... Section 212
8. Piping Accessories:
 - a. Pressure gauge shall be a 3-1/2 inch diameter dial, Ashcroft Type 1009, or approved equal, with a scale range approximately 2 times the operating pressure.
 - b. Ball Valves: Bronze Ball valves shall be rated for the pressure and temperature of the service fluid. Materials of construction for valves shall be compatible with service fluid.

- c. Strainers: Strainer shall be of Y-pattern, bronze body, with 80 mesh screen.
 - d. Dielectric Unions shall separate all ferrous and nonferrous metals in all piping systems. Unions shall be copper with bronze body, 200 psig, except that of metal-to-metal contact shall be avoided. For pipes 2" and smaller use ground joint, for pipes 2-1/2" and larger used flanged face. Where flanges are used, the bolts shall be electrically insulated from the body of the flange.
 - e. Escutcheons: Brass body, chrome-plated finish. Of sizes sufficient to cover pipe openings through the floor, wall, or ceiling. Escutcheons shall be secured in place by either spring clips or setscrews.
 - f. Pipe Sleeve: Schedule 40 Type 316 stainless steel pipe sleeves in concrete, 18 gauge Type 316 stainless steel sheet metal sleeves in other construction. Sleeves shall be sized to provide a minimum of 1/4" clearance around bare or insulated piping or as otherwise required by Code.
 - g. Hose Bibb: Watts No. 11-4 with vacuum breaker, 3/4" hose thread outlet, removable key handle.
- B. COPPER TUBING: Water pipe 3" in diameter and smaller for water lines shall be Copper Water Tube Type K, soft temper, conforming to ASTM Designation B-88. Solder-joint fittings shall be cast bronze or wrought copper conforming to ANSI B-16. Solder shall be 1/8" diameter, 95% Tin-5% Antimony and shall not contain any lead.
- C. BACKFLOW PREVENTER: The Backflow Preventer shall operate on a reduced pressure principle to prevent back-siphonage and back pressure backflow of water into the potable water supply. The device shall consist of a pressure differential relief valve located in a zone between two positive seating check valves. The relief valve shall contain a separate means whereby free air will enter the zone, and contained water will be discharged to atmosphere when the valve is fully open. The assembly shall include two tightly closing

shut-off valves before and after the device, test cocks and a protective strainer upstream of the No. 1 gate valve. The device shall be suitable for service in either cold or hot water (to 210°F) and shall meet the requirements of ASSE Std. 1013; AWWA Std. C506-78 or USCFCC Manual for Cross Connection Control. The backflow preventer shall be a Watts Series 909QTS, or approved equal.

D. RESERVOIR INFLUENT CONTROL VALVE:

1. Four-Inch Size: This valve shall be a modified globe-type, hydraulically operated by a double-acting diaphragm. An externally-mounted, auxiliary hytrol valve shall control the remote control feature and a pressure relief control valve shall control the main valve operation. A CF1-C1 float control valve shall be mounted inside the reservoir and its operation shall be in response to the reservoir water level. When the water level reaches a certain maximum level the float control directs water to enter the auxiliary hytrol cover and closes it. This, in turn, causes flow through the closing speed control and into the main valve cover and closes the main valve. When the water level reaches a certain minimum level the float control allows water to bleed from the auxiliary hytrol cover and opens it, which places the main valve under the control of the pressure relief control. The pressure relief pilot shall maintain a user-determined upstream pressure. When upstream pressure falls below the setpoint, the valve shall throttle to maintain the setpoint. Setpoint shall be adjustable within a range of 20 – 200 psi.
The main valve body shall be ductile iron; stem shall be stainless steel; valve trim shall be anti-cavitation design, 316 stainless steel and removable; disc shall be synthetic rubber and the diaphragm shall be nylon fabric, bonded with synthetic rubber. The valve unit shall be Clayton Valve No. 56-03 Combination Pressure Relief and Remote Control Valve, or approved equal. The valve shall be epoxy coated internally and shall have Class 125 flanged ends, unless otherwise indicated on the plans.
2. One and One Half-Inch Size: This valve shall be a modified globe-type, hydraulically operated by a double-acting diaphragm. The solenoid pilot control shall be a direct acting three way solenoid valve controlling a two way auxiliary hydraulic diaphragm valve. Solenoid is controlled by a signal from the reservoir level transmitter or indicator. When the water level reaches a certain maximum level the solenoid

control is de-energized which directs water to enter the auxiliary hytrol cover and closes it. This, in turn, causes flow through the closing speed control and into the main valve cover and closes the main valve. When the water level reaches a certain minimum level the solenoid control is energized and allows water to bleed from the auxiliary hytrol cover and opens it, which places the main valve under the control of the pressure relief control. The pressure relief pilot shall maintain a user-determined upstream pressure. When upstream pressure falls below the setpoint, the valve shall throttle to maintain the setpoint. Setpoint shall be adjustable within a range of 20 – 200 psi.

The main valve body shall be ductile iron; stem shall be stainless steel; valve trim shall be anti-cavitation design, 316 stainless steel and removable; disc shall be synthetic rubber and the diaphragm shall be nylon fabric, bonded with synthetic rubber. The valve unit shall be Clayton Valve No. 58-07 Combination Pressure Relief and Solenoid Control Valve, or approved equal. The valve shall be epoxy coated internally and shall have Class 125 flanged ends, unless otherwise indicated on the plans.

E. ELECTROMAGNETIC FLOWMETER:

1. General Description:

Electromagnetic flowmeters shall be installed as shown on the plans at the 0.10-MG reservoir influent control valve station and the reservoir effluent line. The meter shall be capable of measuring flow rates and converting them to an analog signal to be sent to the SCADA system specified for this project.

Electromagnetic flowmeter shall be a Toshiba Model LF654 flow detector with a combined LF620 signal converter, or approved equal, conforming to the following specifications.

a. Overall Requirements:

- 1.) Description: This section of the specifications includes the furnishing and installation of an electromagnetic flowmeter at the location described below. The flowmeter shall include an electromagnetic flow sensor and an integral signal converter.

a.) Reservoir Influent Control Valve Station

1. Number required: One.

2. Flowmeter sensor size: 4 inches.
3. Maximum operating pressure: 300 psi.
4. Flange ends: ANSI Class 150.
5. Location: As shown on the plans.

b.) Reservoir Effluent Line

1. Number required: One.
2. Flowmeter sensor size: 8 inches.
3. Maximum operating pressure: 300 psi.
4. Flange ends: ANSI Class 150.
5. Location: As shown on the plans.

b. Sensor:

- 1.) Operating Principle: Utilizing Faraday's Law of Electromagnetic Induction, the flow of liquid through the sensor induces an electrical voltage that is proportional to the velocity of the flow.
- 2.) Construction: The flow sensor tube shall be 304 stainless steel surrounded by two coils. Liner material shall be NSF approved. Connecting flanges shall be carbon steel, ANSI Class 150. Meter body pressure rating shall be equal to two times the integral flange pressure rating.
- 3.) Installation: A minimum of 5 pipe diameters upstream and 3 pipe diameters downstream of straight pipe are required. No taps for gauges, instrumentation, etc. shall be allowed within this straight pipe section.
- 4.) Electrodes: Conical self-cleaning measurement electrodes shall be 316 stainless steel or Hastalloy C, or approved equal.
- 5.) Grounding electrodes: Rings or grounding electrodes shall be 316 stainless steel.
- 6.) Operating temperature: -4 to 140°F.
- 7.) Enclosure Rating: NEMA 4X watertight.

c. Signal Converter:

- 1.) Enclosure: NEMA 4X watertight.

- 2.) Display: LCD full dot-matrix 128x128 dot with back-light. 16-character display to indicate flow rate, totalized values, settings, and faults.
- 3.) Control Keys: Allows for external configuration without removing covers and compromising the integrity of the electrical and environmental classifications.
- 4.) Bi-directional flow: Forward and reverse flow indication and totalization.
- 5.) Totalization: Minimum of two eight-digit counters for forward, net, or reverse flow.
- 6.) Mounting: Integral mounting, unless otherwise shown on the plans.
- 7.) Enclosure: NEMA 4X polypropylene with polycarbonate window.
- 8.) Power supply: 115/230 VAC or 24 VDC.
- 9.) Galvanic isolation: All inputs and outputs are galvanically isolated.
- 10.) Current output: 4-20 mA into 750 ohms max. Contractor shall confirm the unit output and power requirements with the SCADA system and provide the necessary appurtenances for compatibility.
- 11.) Pulse output: Digital (frequency or pulse) for external display of flow rate or totalization.
- 12.) Empty pipe detector: Required.

d. Sensor and Signal Converter Performance:

- 1.) Flow range: 1.0 to 39.4 feet per second for the accuracy stated below for the 4-inch flow meter and 0.3 to 1.0 feet per second for the accuracy stated below for the 8-inch flow meter.
- 2.) Accuracy: 0.5 % of actual flow.

- 3.) Calibration: 3 points minimum, witnessed.
- e. Spare Parts: Spare parts for the equipment shall include the following, unless otherwise noted.
- 1.) One set of manufacturer's recommended spare parts.
 - 2.) Two additional copies of the Operations Manual.
- f. Calibration of Flow Sensor:
- 1.) Each flow sensor shall be wet calibrated and all of the calibration information and factory settings matching the sensor shall be stored in an integrally mounted memory unit or converter. The memory unit shall store sensor calibration data and signal converter settings for the lifetime of the product. At initial commissioning, the flowmeter shall commence measurement without any initial programming. Any customer specified settings are downloaded to the memory unit. A certification of calibration shall accompany each flow sensor.
 - 2.) Test mode: Provide the ability to verify the accuracy of the unit and the integrity of the current loop without any external equipment.
 - 3.) Self diagnostics: Internal checks of all outputs and displays.
 - 4.) In-situ calibration verification: The equipment shall be able to verify in a quantifiable manner the meter's current conditions versus the meter's condition when originally manufactured. This calibration verification of the meter shall be performed without need for physical access to the flow sensor unit. The calibration verification shall meet or exceed the following requirements:
 - a.) The original FINGERPRINT values shall be stored on a computer disk given to the Engineer and to the Department of Water Supply.
 - b.) The verification process shall consist of a minimum of 20 meter conditions

pertaining to the primary coils, electrodes, interconnecting cable, and signal converter.

- c.) The coil verification shall include faults of continuity, impedance, resistance to ground, inductance, and magnetic strength.
- d.) The electrode verification shall include faults of continuity, impedance, and insulation.
- e.) The cable verification shall include faults of coil, electrode, driven shield, and ground connections, cable cuts, cable damage, and water in the cable.
- f.) Signal converter verification shall include faults of current supply to coils, zero offset, span forward and reverse, electrode offset, current output, frequency output forward and reverse, driven shield to ground, overall shield to ground, and signal ground connection to ground.
- g.) The calibration verification shall include the following: water ingress into the primary elements, faulty electrodes, electrode leakage, corroded electrodes, high process noise, liner failure, conductive coatings on the liner, and primary element damage.
- h.) All tests shall be performed by means of comparison between the absolute values and change in values from the new conditions.
- i.) Verification standard shall be $\pm 1\%$ of wet calibration for meters produced using the calibration verification service, or $\pm 2\%$ for standard meters.
- j.) The software shall be Windows based. This software shall be capable of generating a report based upon the results of the foregoing described tests. The software shall be capable of creating and storing an audit trail of the meter's conditions and meter's history.

k.) The calibration verification and metering system shall meet or exceed the standards established by the National Testing Laboratories.

l.) Meters shall be designed, manufactured, and calibrated in an ISO 9001, NAMAS, NIST, NATA certified facility. Flow facility must be certified by volume or weight-certified approvers. Facilities must have the capability to hold the flow rate at the specified calibration points for a minimum of five minutes to allow stabilization for flow and repeatability point checks.

g. Signal converter functions:

The following functions shall be provided.

- 1.) All programming shall be accomplished through an integral keypad and all programming shall be protected by a user-defined password.
- 2.) The signal converter shall be integrally mounted.
- 3.) The signal converter shall provide a 0/4-20 mA DC signal proportional to flow rate into 750 ohms max.
- 4.) The relay shall be programmable as error indicator, limit alarm, or pulsed output.
- 5.) The signal converter system shall be equipped with an error and status log to show meter error or warnings for the meter's operation.
- 6.) A system error shall be indicated by a flashing icon on the display or activation of the relay when set as an error alarm. Show all errors until they are user corrected or reset.

G. FLOW INDICATOR/TOTALIZER: Flow indicator shall be a Precision Digital Model PD2-6200, or approved equal, designed for wall mounting. The indicator shall accept a 4-20 mA input signal from the flow transmitter. The indicator shall provide a continuous 6-digit display of the flow in GPM. The display shall be at least 1/2-inch-high, red, and sunlight

readable. Indicator accuracy shall be +0.5% span. One 4-20 mA auxiliary output shall be provided.

1. Reservoir Influent Flow

- a. Number required: One.
- b. Flow input signal: From reservoir influent flow meter.
- c. Location: Gauge cabinet as shown on the plans.

2. Reservoir Effluent Flow

- a. Number required: One.
- b. Flow input signal: From reservoir effluent flow meter.
- c. Location: Gauge cabinet as shown on the plans.

H. RESERVOIR LEVEL TRANSMITTER: Pressure transmitter, static water pressure application, indicating type, Foxboro Model IGP10 with silicon strain gauge microsensor. Electronic solid-state circuitry. 0 to 20 feet scaled indicator, 4-20 mA output. Maximum working pressure of 30 psi. Power source from remote loop-type current power supply, 22 mA minimum. Furnish with weatherproof enclosure and install with mounting bracket for 2-inch pipe mounting.

I. RESERVOIR LEVEL INDICATOR: Reservoir level indicator shall be a Precision Digital Model PD2-6001, or approved equal, designed for wall mounting. The indicator shall accept a 4-20 mA input signal from the reservoir level transmitter. The indicator shall provide a continuous 6-digit display of the well level in feet and inches to the nearest 1/16 of an inch. The display shall be at least 1/2-inch-high, red, and sunlight readable. Indicator accuracy shall be +0.5% span. One 4-20 mA auxiliary output shall be provided.

PART 3 - EXECUTION

3.01 GENERAL

- A. The Contractor shall be responsible for precisely laying out the various exterior utility lines shown on the Contract Drawings as provided elsewhere in these Specifications. The location shown on the Contract Drawings of the various existing utility lines which the new lines are to cross over or under or connect to were determined on the basis of the best information available; however, no assurance can be provided that the actual locations will be

precisely as shown on the Contract Drawings. The Contractor shall tone, locate and carefully expose all existing utilities crossing the new water line prior to the installation of the water line.

In performing all work, the Contractor shall exercise due care and caution necessary to avoid any damage to and impairment in the use of any existing utility lines. Any damage inflicted on existing lines resulting from the Contractor's operations shall be immediately repaired and restored as directed by the Department at the Contractor's expense.

3.02 EQUIPMENT

- A. All equipment necessary and required for the proper construction of the water lines shall be on the project, in first class working condition, and approved by the Department before construction is permitted to start.
- B. The Contractor shall provide hand tampers and pneumatic tampers to obtain the required compaction of the pipe bed and the backfill, as specified.

3.03 TRAFFIC CONTROL

- A. Traffic warning and construction signs shall be installed and detours provided as required when working in roadways. The Contractor shall provide, install, and maintain all other necessary signs, lights, flares, barricades, markers, cones, and other protective facilities and shall take all necessary precautions for the protection and the convenience and safety of the public traffic. All such protective facilities and precautions to be taken shall conform with the "Rules and Regulations Governing the Use of Traffic Control Devices at Work Sites on or Adjacent to Public Streets and Highways" adopted by the Director, Department of Transportation, and the U.S. Federal Highway Administration "Manual on Uniform Traffic Control Devices for Streets and Highways, Part VI - Traffic Control for Highway Construction and Maintenance Operation", dated 2003.
- B. All detour plans shall be submitted to the Department for approval prior to implementation of the detour. Advance notification of changes in traffic patterns shall be provided to users as directed by the Department.

3.04 TRENCH EXCAVATION AND BACKFILL

- A. The Contractor shall do all necessary trench excavation to the depth required by the plans, including the excavation for pipe cushion. The excavation shall be done in accordance with the "Water System Standards", dated 2002 of the Department of Water Supply, County of Hawaii and Section 02200 - EARTHWORK.
- B. When unsuitable material is encountered at the excavation the Contractor shall be responsible for hauling and disposing of the material and filling the excavation with crushed rock cushion material.

3.05 INSTALLATION

- A. All work shall be in accordance with the appropriate Sections of Division 300 of the WATER SYSTEM STANDARDS.
- B. Concrete reaction blocks shall be provided at all bends and plugged ends in accordance with the WATER SYSTEM STANDARDS for ductile iron pipes. The minimum bearing area shall be for Class 250 pipe and Type B soil condition for pipes located within volcanic ash soils or Type F condition for pipes located within the basalt stratum.

3.06 DETECTION OF WATER LINES

- A. Warning and Identification Tape:
 - 1. Provide warning and identification tape for both non-metallic and metallic water lines.
 - 2. The warning and identification tape shall be buried directly above the center-line of the utility pipe, approximately 12" below the finish grade. Where the utility pipe is under pavements and slabs, the tape shall be buried approximately 6" below the top of the subgrade.

3.07 DETAILS

Standard Details shall be in accordance with Section 403 of the WATER SYSTEM STANDARDS or as shown on the plans.

3.08 CONNECTING, TESTING, CHLORINATION

- A. The new lines shall be installed, but not connected until pressure testing and disinfecting is completed. Connecting shall be done at the discretion of the Department of Water Supply. Pressure testing

and, flushing of valves and mains shall be carried out in accordance with the "Water System Standards". The Contractor shall submit the results of such test to the Department for approval. All charges for services by the Department of Water Supply shall be paid for by the Contractor.

- B. The shut-off of water service shall be done during the working hours. The Department of Water Supply and the Department shall be notified 72 hours in advance of any shut-off of the water service. The Contractor shall notify the Fire Department of any shut-off involving existing fire hydrants.
- C. Disinfection of Water Lines
 - 1. Flush out water lines to remove foreign matter. After flush water runs clear, disinfect the lines with chlorine in accordance with AWWA Standard C651, pertaining to methods, concentrations, and contact times. Flush out until residual is reduced to 0.3 ppm. Submit to the Department a certificate of completion for this work from a contractor experienced and licensed to do disinfecting work.
 - 2. Obtain two water samples from selected points and submit them to a licensed laboratory for bacteriological testing. Water shall meet Federal water purity standards. Submit to the Department a laboratory report or a certification of satisfactory completion of disinfection. All costs of testing shall be borne by the Contractor. Notify the Department in writing if the County Water Supply to the site exceeds maximum permissible limits for coliform content.

3.09 RESTORE PAVEMENTS AND OTHER IMPROVEMENTS

- A. All trenches within pavements shall be repaved in accordance with the plans and specific sections of the standard DPW Specifications Section 38 - RESTORING PAVEMENTS AND OTHER IMPROVEMENTS shall apply. All striping and pavement markings shall be repainted in their entirety should any portion of the stripe or markings need repainting.
- B. All trenches within yard areas shall be covered with 6 inches of topsoil and the area regrassed in accordance with Section 02920 – LAWNS AND GRASS.

- C. All curbs, gutters, sidewalks, and other miscellaneous improvements removed or damaged by the work shall be reconstructed.

3.10 FINAL INSPECTION

At the time of final inspection of the work performed under the contract, the water system shall be complete in every respect and operating as designed. All surplus materials in every character resulting from the work of this section shall have been removed. All defects discovered in the utilities subsequent to this inspection shall be corrected prior to final acceptance.

END OF SECTION

SECTION 03200 – CONCRETE REINFORCING

PART 1 – GENERAL

1.1 DESCRIPTION:

- A. This item of work consists of furnishing of labor, tools, equipment, and materials necessary to complete this item of work, in place complete, as shown on the plans and as specified in DIVISION 300 - CONSTRUCTION, Section 303.04 REINFORCING STEEL, and Section 303.05 WELDED WIRE FABRIC of the Water System Standards, 2002, and as amended hereinafter as they apply to this project.

1.2 SUBMITTALS:

- A. The Contractor shall furnish shop bending diagrams, placing lists, and drawings of all reinforcement steel before fabrication.
- B. Details of reinforcement steel for fabrication and erection shall conform to ACI 315 and the requirements indicated. The shop bending diagrams shall show the actual lengths of bars, to the nearest inch, measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface. The shop drawings shall include bar placement diagrams which clearly indicate the dimensions of each bar splice.
- C. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, the Contractor shall submit manufacturer's literature including instructions and recommendations for installation for each type of coupler used; certified test reports which verify the load capacity of each type and size of coupler used; and shop drawings which show the location of each coupler with details of how they are to be installed in the formwork.
- D. If reinforcement steel is spliced by welding at any location, the Contractor shall submit mill test reports which shall include the information necessary to determine if the carbon equivalent is as specified in AWS D1.4. The Contractor shall submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding; a mere statement that AWS procedures will be followed will not be acceptable.

PART 2 – MATERIALS

2.1 MATERIALS:

- A. Reinforcing steel shall conform to ASTM A615, Grade 60, typical.

- B. All welded reinforcement, specifically detailed or otherwise indicated, shall be low-alloy grade 60 deformed bars conforming to the requirements of ASTM A706.
- C. Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A82.
- D. Tie wire shall be Annealed Steel, 16 gauge minimum.
- E. The use of re-rolled rail steel or cold twisted bars is not permitted.
- F. Mechanical Couplers:
 - 1. Mechanical couplers shall be provided where indicated and where approved by the Manager. The couplers shall develop a tensile strength that exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice.
 - 2. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied.
 - 3. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross section of the bar.

PART 3 – EXECUTION

3.1 GENERAL:

- A. All reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the requirements of the ACI 318 and the supplementary requirements indicated herein.
- B. Fabrication and Delivery:
 - 1. The Contractor shall conform to CRSI MSP, Chapters 6 and 7, except as otherwise indicated or specified. The Contractor shall bundle reinforcement and tag with suitable identification to facilitate sorting and placing, and transport and store at site so as not to damage material. The Contractor shall keep a sufficient supply of tested, approved, and proper reinforcement at site to avoid delays.
 - 2. Bending and Forming: The Contractor shall bend bars of indicated size and accurately form in accordance with the requirements of ACI 315 and

ACI 318 to shapes and lengths indicated on drawings and required by methods not injurious to materials. The Contractor shall not heat reinforcement for bending. Bars with kinks or bends not scheduled will be rejected.

3. Fabricating tolerance: All fabrication of reinforcing bars shall meet the requirements of ACI 117.

C. Placing:

1. Reinforcement steel shall be accurately positioned and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcement steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used, in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. All concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties which are embedded in the blocks. For concrete over formwork, the Contractor shall furnish concrete, metal, plastic, or other acceptable bar chairs and spacers.
2. Limitations on the use of bar support materials shall be as follows:
 - a. Concrete Dobies: Permitted at all locations except where architectural finish is required.
 - b. Wire Bar Supports: Permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.
 - c. Plastic Bar Supports: Permitted at all locations except on grade.
3. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.
4. Bars additional to those shown which may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position shall be provided by the Contractor at no additional cost to the owner.
5. Unless otherwise specified, reinforcement placing tolerances shall be within the limits specified in Section 7.5 of ACI 318.
6. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances,

the resulting arrangement of bars shall be subject to the approval of the Manager.

7. Accessories supporting reinforcing bars shall be spaced such that there is no deflection of the accessory from the weight of the supported bars. When used to space the reinforcing bars from wall forms, the forms and bars shall be located so that there is no deflection of the accessory when the forms are tightened into position.

3.2 MINIMUM OVERLAP:

- A. Minimum overlap for lapped splices shall be 40 bar diameters, but not less than 2'-0". Splices shall be staggered at least 24 inches.

3.3 SPLICES:

- A. Splicing shall be in accordance with ACI-318, unless otherwise noted on Drawings.
- B. Vertical Bars. Except as specifically detailed or otherwise indicated, splicing of vertical bars in concrete is not permitted, except at the indicated or approved horizontal construction joints or as otherwise specifically detailed.
- C. Horizontal Bars. Except as specifically detailed or otherwise indicated, splicing of horizontal bars in concrete is not permitted.
- D. Mechanical Couplers. Only allowed with prior written approval by the Manager. Follow manufacturer's requirements for installation.
- E. Welded splices shall be provided where indicated and where approved by the Manager. All welded splices of reinforcement steel shall develop a tensile strength which exceeds 125 percent of the minimum yield of the reinforcing bars.

PART 4 – PAYMENT

No separate payment for will be made; compensation for such work shall be deemed to be included in the Lump Sum Bid for the item of which it is a part.

END OF SECTION

SECTION 03210 – EARTHQUAKE CABLES

PART 1 – GENERAL

1.1 DESCRIPTION:

- A. Furnish of all labor, materials, tools and equipment necessary to complete the tank earthquake cables work.

1.2 SUBMITTALS:

- A. The Contractor shall submit five copies of fabrication drawings specifying the quantity, location and details for the Manager's approval before the earthquake cables are fabricated.

PART 2 – MATERIALS

2.1 EARTHQUAKE CABLE STRANDS:

- A. Where called for on the Drawings, earthquake cables consisting of 7-wire galvanized strands, meeting the minimum physical and strength requirements listed here.

<u>Item</u>	<u>Specification</u>
1. Nominal strand diameter:	1/2"
2. Nominal area after galv.:	0.153 in ²
3. Nominal weight/1000 LF:	541 lbs.
4. Pitch (Strand diameters):	12-16
5. Tensile strength (min.):	38,200 lbs.
6. Yield strength @ 1% extension (min):	28,500 lbs.
7. Elong. in 24" at fracture (min.):	4.5%
8. Weight of zinc coating (min.):	0.85 oz./ft. ²

- B. The seismic cables shall be installed to connect wall to wall footing.
- C. The strands shall be hot-dipped galvanized before stranding with a minimum zinc coating of 0.85 oz./ft².
- D. Galvanized strands for earthquake cables shall meet the quantity, length and spacing specified on the Drawings.

2.2 CELL NEOPRENE SEISMIC CABLE SLEEVES:

- A. Neoprene sleeves for seismic cables, which encase the galvanized strands, shall conform to the minimum dimensions shown on the Drawings to allow

unrestrained flexing of the strands inside the sleeves under the maximum projected radial wall movements.

- B. The material shall be medium grade closed cell neoprene conforming to 2A3 of ASTM D 1056-85 and as further specified here in and on the Drawings.

1. Compression deflection:	9-13 PSI
2. Density:	18-28 PCF
3. Water absorption by weight:	0.5 lbs/ft2
4. Temperature range:	
Low (flex without cracking):	-30°F
High continuous:	150°F
High intermittent:	200°F
5. Heat aging (7 days @ 158o F):	5% lineal shrinkage (max.)
6. Tensile strength:	115 PSI min.
7. Elongation:	170% min.
8. Resilience:	20% 40% (bayshore % rebound average 1/2" thickness @ 72°F)

- C. CYPRESS SPONGE 431N or 423N, or approved equal, are acceptable materials.

2.3 MILD STEEL REINFORCING BARS

- A. The mild steel reinforcing bars for the support of the earthquake cable anchors shall conform to the requirements of Water System Standards, Section 303.04, REINFORCING STEEL and as amended herein these technical provisions as they apply to this project.

PART 3 – EXECUTION

3.1 EARTHQUAKE CABLE INSTALLATION

- A. Cable sets shall be installed equally spaced and in equal number in each quadrant of the reservoir wall. The spacing shown on the Drawings is only approximate and the number of cable sets specified is the governing criteria for placement.
- B. Where necessary, the strands shall be pre-bent before placing into wall and wall footing forms, as called for on the Drawings.
- C. The strands shall be separated and tied to circumferential wall reinforcing as required and shown on the Drawings.
- D. In the footing, the strands shall be fanned out and tied to the top of the radial bars at the bottom of the footing.

PART 4 – PAYMENT

No separate payment for will be made; compensation for such work shall be deemed to be included in the Lump Sum Bid for the item of which it is a part.

END OF SECTION

SECTION 03300 – CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 DESCRIPTION:

- A. Furnish all materials, labor and equipment required to accomplish all concrete work specifically for the concrete reservoir tank, as shown on the plans and as specified in DIVISION 300 - CONSTRUCTION, Section 303.03 CONCRETE WORK, of the Water System Standards, 2002, and as amended hereinafter as they apply to this project.

1.2 QUALITY ASSURANCE:

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."
- F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specifications for Structural Concrete,"

2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

- G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

1.3 SUBMITTALS:

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 1. Mix design shall list quantities to be used for a cubic yard of concrete. List all admixtures and proposed quantity to be used for each admixture. Specify range of slump and water-cement ratio. List sources of aggregates to be used and provide sieve analysis of each aggregate demonstrating compliance with Water System Standards gradations listed in Table 300-7 and 300-8.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.
 2. All false work and forming requirements for roof support systems must be designed by an engineer registered in the State of Hawaii. The drawings, with supporting calculations, must each be signed and sealed by the engineer. No work shall be started until the roof support system and form design has been submitted. The false work design engineer must visit the site and approve the erection of all shoring prior to the placement of any concrete.
- E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 1. Location of construction joints is subject to approval of the Engineer.
- F. Qualification Data: For Installer, manufacturer, and testing agency.
- G. Welding certificates.

H. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Curing compounds.
6. Bonding agents.
7. Adhesives.
8. Vapor retarders.
9. Semirigid joint filler.
10. Joint-filler strips.
11. Repair materials.

I. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates.

1.4 DELIVERY, HANDLING, STORAGE

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Cement and aggregates shall be stored in a manner to prevent deterioration or the intrusion of foreign matter. Any material which has deteriorated or that has been damaged shall not be used for concrete and shall be promptly removed from the batching site.

PART 2 – MATERIALS

2.1 CEMENT, WATER & AGGREGATES:

- A. General: Materials shall be in conformance with County of Hawaii, Standard Specifications for Public Works Construction, September 1986, Section 39.
- B. Portland Cement: ASTM C 150, Type I or Type II.
- C. Normal-Weight Aggregate: ASTM C 33, uniformly graded, and as follows:
 1. Class: Moderate weathering region, but not less than 3M.
 2. Aggregate Size: No. 57 (1 inch to 3/8 inch).
- D. Water: Potable and complying with ASTM C 94 or non-potable meeting ASTM C-94 Acceptance Criteria for Questionable Water Supply. Use only potable water for job site mixing.

2.2 ADMIXTURES:

A. Retarding Densifiers

1. All 'DWS 4000' concrete used for wall construction, shall also contain DARATARD-17, as manufactured by Grace Const. Products, Cambridge, MA or MBL-82, as manufactured by Master Builders, Cleveland OH in the amounts recommended by the additive manufacturer whenever the air temperature during the pour exceeds 85° F.
2. To be considered as equal, any alternate product offered for consideration shall contain no calcium chloride, and shall be compatible with air-entrained cements and air-entraining admixtures conforming to the applicable ASTM, AASHTO, ANSI and Federal specifications.
3. Contractor shall certify that admixtures do not contain calcium chlorides or other corrosive materials.

B. Air-Entraining Agents

1. Unless specifically required by the Department of Water Supply, 'DWS 4000' concrete shall not be air-entrained. Unless otherwise specified, all other concrete may be air-entrained at the option of the Contractor.
2. Air-entraining agents shall meet ASTM C-260, ASTM C-233 and ASTM C-457.
3. The maximum total volumetric air content of the concrete before placement shall be 6 percent plus or minus one percent as determined by ASTM C-173 or ASTM C-231.
4. Subject to these Specifications, consideration will be given to the following products: PROTEX "AES", GRACE "DAREX AEA", MASTER BUILDERS "MB-AE10", OR SIKA CHEMICAL "AER".

C. Water-Reducing Admixtures

1. In addition to air-entrainment, approved water reducing additives, which do not affect the ultimate performance of any steel in any way, may be added to maintain the maximum water content below that specified herein. Water reducing additives shall conform to ASTM C494, Type A.
2. The use of water reducing additives shall not permit a reduction in the minimum specified cement content or in the specified amount of air-entrainment.
3. Admixtures shall contain no calcium chloride, tri-ethanol amine or fly ash. All admixtures shall be from the same manufacturer.

4. Superplasticizers, if allowed by the Manager, shall conform to ASTM C494, Type F or G, batch plant added using second or third generation only.

D. Shrinkage-Reducing Admixture

1. Shrinkage reducing admixture shall not contain any expansive material, but reduces material shrinkage by chemical action to reduce the surface tension of water. The admixture shall provide a minimum 50% reduction in the ultimate shrinkage at the dosage proposed.
2. Subject to these Specifications, consideration will be given to the following products: BASF "TETRAGUARD AS 20", GRACE "ELIPSE PLUS", or approved equal.

- E. Crystalline Waterproofing Admixture: Admixture shall be designed to be added during concrete batching, the product reacts with moisture in fresh concrete and by-products of cement hydration to cause a catalytic reaction that generates a non-soluble crystalline formation throughout the pores and capillary tracts of the concrete permanently sealing the concrete.

2.3 CONCRETE CLASSES:

- A. DWS 4000 – Reservoir wall, columns, roof slab, floor slab and foundation, pipe jackets under floor slabs and for items specifically noted on Drawings. The maximum water-cement ratio shall be 0.42. All concrete used in this class concrete shall include a crystalline waterproofing admixture.
- B. DWS 3500 – Pipe jackets, and all building concrete, and for items specifically noted on Drawings. The maximum water-cement ratio shall be 0.46.
- C. DWS 2500 - All other concrete where strength is not indicated or shown, it shall be minimum 3,000 psi at 28 days.

2.4 EPOXY ADHESIVE:

- A. Epoxy Adhesive shall be two-component, injectable, meeting the requirements of ASTM C881, Type IV, Grade 3. The adhesive product shall have a current ICBO or ICC ES Report permitting the use of the product in uncracked and cracked hard rock concrete with reinforcing steel dowels, such as Hilti 'HIT-RE 500-SD Injectable Mortar' or Simpson 'SET-XP Adhesive' or approved equal.

PART 3 – EXECUTION

3.1 PROPORTIONING:

- A. In addition to the requirements for "Proportioning Concrete Mix" specified in Section 303.03.C of the Water Systems Standards, the concrete mix design for elements of the concrete reservoir shall have a maximum water-cement ratio as stated in Section 2.3.
- B. The contractor has the option of including a shrinkage-reducing admixture to the reservoir concrete mix design in order to reduce the possibility of shrinkage cracks forming in reservoir concrete, however it is the responsibility of the contractor to verify admixtures used are compatible and will not result in undesirable properties in the concrete. Trial batches will be required to assure compatibility if manufacturers will not provide written confirmation of admixture compatibility.

3.2 HOT WEATHER CONCRETING:

A. General

- 1. Description: Hot weather is defined as any combination of high air temperature, low relative humidity and wind velocity that results in a rate of evaporation of 0.2 pounds per square foot per hour based upon the evaporation rate determined by Figure 2.1.5 in ACI 305. During hot weather, any or all of the methods specified herein for temperature control of concrete shall be used as required to maintain the concrete temperature below the limits specified.
- 2. Shop Drawings: Not less than 30 days prior to expected placement of concrete under hot weather conditions, a complete procedure shall be submitted for review covering the aspects of protection of concrete and its ingredients from the detrimental effects of hot weather. Concrete placement during hot weather shall not commence prior to the return of the procedure marked "Reviewed".
- 3. Product Delivery, Handling and Storage
 - a. Aggregate piles, cement bins and batch plant bins shall be shaded from the direct rays of the sun.
 - b. Aggregate piles shall be cooled by wetting and evaporation. Aggregate wetting shall be performed in such a manner that it will not cause wide variations in moisture content impairing slump uniformity.
- 4. General Practices and Measures; The following list of practices and measures, as described in ACI 305, may be used to reduce or avoid the potential problems of hot weather concreting:
 - a. Use concrete materials and proportions with satisfactory records in field use under hot weather conditions.

- b. Use cool concrete.
- c. Use a concrete consistency that permits rapid placement and effective consolidation.
- d. Transport, place, consolidate, and finish the concrete with least delay.
- e. Plan the job to avoid adverse exposure of the concrete to the environment; schedule placing operations during times of the day or night when weather conditions are favorable.
- f. Protect the concrete against moisture loss at all times during placing and during its curing period.

B. Batching and Mixing

- 1. Concrete mix water shall be refrigerated or up to 100 percent of the water requirement may be ice added to the concrete mix. Ice, when introduced into the mixer, shall be in such form that it will completely melt and dispersed into the mix at the completion of the mixing time. The mixing time shall be held to the minimum practicable consistent with producing concrete meeting the specified requirements
- 2. All methods and equipment for cooling water and aggregate shall be subject to the approval of the Manager and shall conform to ACI 305.

C. Concrete Temperature: The temperature of concrete, as delivered at the time and location of placement, shall not exceed 100°F under any conditions. The temperature of concrete as delivered at the time and location of placement under the following combined ambient conditions, except concrete that will be deposited within wall or column forms, shall not exceed the following temperatures:

Relative Humidity less than %	Ambient Temperature greater than °F	Maximum Concrete Temperature, °F
80	90	100
70	90	95
60	90	90
50	90	85
40	90	80
30	80	75
20	75	70

D. Delivery: Concrete shall be placed in the Construction within 90 minutes after the completion of mixing.

- E. Preparation for Placing: Elevated forms and reinforcing steel for beams and slab members shall be cooled by fog spraying and evaporation immediately prior to placing concrete. Forms shall be free of standing water when concrete is placed herein.
- F. Placing: Concrete shall be placed in shallower layers than under normal weather conditions, if necessary, to assure coverage of the previous layer while it is still in plastic state and will respond readily to vibration.
- G. Finishing: Fog spray shall be used during finishing operations whenever necessary to avoid surface plastic shrinkage cracking. Fog spray shall also be used after finishing and before the specified curing is commenced to avoid surface plastic shrinkage cracking.
- H. Protection and Curing: Forms shall be kept covered and continuously moist. Once forms are loosened and during form removal, concrete surfaces shall be protected from drying and shall be kept continuously wet by fog spraying or other approved means.

3.3 FIELD TESTING

- A. Replace the third paragraph in Section 303.03.L, "Field Tests of Concrete" with the following:

Five cylinder samples shall be taken for each class of concrete poured each day and for every 50 cubic yards of each class or fraction thereof. Two (2) cylinders shall be tested at age of seven (7) days and twenty-eight (28) days in accordance with ASTM C39, "Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens". The last sample shall be held in reserve for use to verify suspect test results or a spoiled test sample.

- B. Slump tests shall be conducted on each ready-mix concrete truck discharging on-site for project site.

3.4 FORM WORK

- A. General:

Forms shall be so constructed that they can be removed without hammering on, or prying against, the concrete and shall be removed in such a manner as to prevent damage to the concrete and to insure the complete safety of all parts of the structure. Forms previously used shall be thoroughly cleaned of all dirt, mortar and foreign matter before being reused.

- B. Reservoir Form Work

1. All vertical wall and column footing sides shall be formed by methods acceptable to the Manager and the design engineer and to the correct elevations and location shown on the Drawings.
2. The wall form design shall be such that wall sections can be poured for the full wall length without any vertical construction joints and without causing snapping of form ties which shall be of sufficient strength and number to prevent spreading of the forms during the placement of concrete and which shall permit ready removal of the forms without spalling or damaging the concrete. A horizontal construction joint can be used at the Contractor's option at the height indicated on the Drawings.
3. Taper ties with plastic or rubber plugs of an approved and proven design may also be used for form ties. The plugs must be driven into the hole with a steel rod, placed in a cylindrical recess made therefore in the plug. At no time shall plugs be driven on the flat area outside the cylindrical recess. Plugs shall be A-58 SURE PLUG as manufactured by DAYTON SUPERIOR, Miamisburg, OH (phone: (800) 745-3700, www.daytonsuperior.com) or approved equal.
4. The BURKE, ECONOMY, SYMONS, ALUMA, and regular plywood forms may be used for forming of circular walls, as long as there are no straight sections longer than 36 inches at any place around the outside circumference of such walls.
5. Unless specified on the Drawings, no chamfer strips shall be placed at the horizontal construction joint forms for reservoir walls.
6. The height of such wall panel forms shall not exceed 8 feet unless built-in pouring openings are incorporated in such wall panels. In this case, pouring of walls shall be done only through pouring openings on one of the wall sides, and may not be pumped or poured from the top using "elephant trunks" or tremies.
7. The pour openings shall be no smaller than 1.5-foot square, and spacing either vertically or horizontally no more than 8 feet. The bottom row of opening shall be no higher than 4 feet from the bottom of the form.
8. If pour windows are not provided, one side of the wall forms shall be no higher than eight (8) feet when the concrete placement begins and the wall forms may be installed in place as the pour progresses. The top of the form shall not be put in place until the height from the concrete surface to the top of the newly-placed form does not exceed nine (9) feet.
9. Forms and falsework supports for the roof shall be sufficiently rigid and strong to support the wet concrete and the workers and equipment

necessary for its placement without appreciable deflections. A minimum of 40 PSF for live-load shall be allowed in the falsework design.

10. The Contractor shall provide either wedges under timber posts, screw jacks under shoring, or other means to adjust the forms and relieve the load.
11. Unless the level of roof screeds remains unaffected by the deflection of roof-forms, an upward camber, where necessary in the opinion of the Manager, shall be provided to all form areas which will deflect under the concrete load.
12. The Contractor shall determine if additional camber is required for the roof slab form to permit concrete and steel to act efficiently without development of deflection cracks.

C. Form Work Tolerances

1. Wall form sills shall be used to contain or hold down neoprene pads and facilitate proper alignment of forms. The maximum permissible variation in the horizontal and vertical location of the waterstops, neoprene pads and seismic cables (if required) is plus or minus 1/4 of an inch.
2. The maximum permissible variation in tank radius, as measured from the center of the tank to the inside wall surface at the bottom, is plus or minus 3/8 of an inch.
3. Out-of-round tolerance: 3/4" in 50 feet, 3/8" in 10 feet and 3/16" in 2 feet from the true curvature specified at any point on the wall.
4. The maximum permissible variation in the vertical alignment, from the bottom to the top of the wall, in plus or minus 3/8 of an inch.
5. The permitted tolerance of the average wall thickness for poured walls shall not vary more than 1/8-inch either way. All transitions from plus to minus shall be more gradual, even and smooth, and without abrupt changes in the surfaces.
6. Unless stated otherwise on the Drawings, the permissible tolerance at any point for flat roof form-surfaces shall not exceed plus or minus 1/4 inch from the specified elevation or thickness. The finished roof surface shall be capable of draining completely. Contractor shall camber or provide necessary forming supports to prevent low spots and to insure drainage. If low spots should occur, Contractor shall submit a corrective procedure to the Manager for approval.

7. Slab screeds and bulkheads shall be set to specified alignment and elevations permitting a maximum tolerance of 1/4 inch plus or minus.
8. Any transition between high and low points of the finished roof slab shall be gradual, smooth and even, and shall be to the satisfaction of the Manager.
9. Adequate time and cooperation shall be provided to the Department of Water Supply Construction Inspector and design engineer to verify the compliance of these requirements prior to closing up the forms or pouring concrete.

3.5 FORM WORK REMOVAL

The following shall replace the times stated in table on WSS Section 303.O.3 (Page 303-16) only for specific items described:

- A. Removal of wall and column forms shall not be started any sooner than 24 hours of accumulated time with the ambient air temperature above 50 degrees F after completion of the wall or column pour, respectively.
- B. Wall and column forms may be removed as soon as the concrete has developed sufficient strength to prevent sagging, excess deflection, misalignment, spalling, cracking, breaking of edges and surfaces and any other damage to the concrete and the compressive strength of the concrete has reach a minimum of 50% of the required 28-day compressive strength confirmed by concrete cylinder tests. If the Contractor decides to remove forms prior to 14 days, at the Contractor's own expense, additional concrete cylinder shall be molded and cured as specified here-in to verify that the 50% strength requirement above has been achieved, prior to removing the forms.
- C. Removal of roof forms will be permitted only when the concrete has attained the compressive strength equal to the required 28-day compressive strength specified in these Special Provisions or shown on the Drawings, but no earlier than 14 days regardless of the concrete compressive strength.

Add following items to the end of Section 303.03.O.3, "Form Removal":

- D. Contractor shall remove all wood splinters on concrete surfaces after stripping of wood forms.

3.6 CONVEYING, PLACING, AND HANDLING:

Add the items below the end of Section 303.03.P, "Conveying, Placing and Handling":

- A. Concrete in columns, having no horizontal reinforcement crossing into the region bounded by the vertical reinforcement, may be deposited from the top of the column form, at Contractor's option such that no separation of the coarse aggregate from the mortar takes place. All concrete shall be vibrated as required herein. The final quality of the poured concrete column shall be the responsibility of the Contractor. If the quality of the column is found to be unacceptable the Manager, at the Contractor's expense, may require the complete removal of the column and may require that an alternate placement method be used.
- B. Each layer of concrete in walls and columns shall be vibrated thoroughly before the next layer may be placed thereon. Vibrators shall be taken through the top layer down through the full layer thickness below to ensure proper integration of the concrete and to avoid the development of cold joints and honeycomb between the layers. In other words, each layer of concrete shall be vibrated at least twice.
- C. Horizontal waterstops in floor and roof decks, if shown on the Drawings, shall be lifted up, then the concrete shall be placed under the waterstop, the waterstop shall then be laid down on that concrete, additional concrete shall be placed on top of that waterstop to the approximate finish level of the concrete, where upon the concrete shall be thoroughly vibrated in one continuous motion from one end of the waterstop to the other end without skipping any areas. Visual observation shall be performed by the Contractor to certify that voids under waterstops have been eliminated.
- D. Cold joints between bulkheads in floor, roof slabs and in wall footings shall be avoided at all costs. Joints shall be continuously covered with new concrete, and shall be thoroughly integrated through vibration, even if it means that horizontal passes of only 6 inches in width be made until additional concrete and equipment becomes available to permit wider passes in concrete placement.
- E. Protect concrete placed immediately before rain to prevent rainwater from coming in contact with it. Keep sufficient protective covering on hand at all times for this purpose.
- F. Pumping Concrete:
 - 1. Slab screeds and bulkheads shall be set to specified alignment and elevations permitting a maximum tolerance of 1/4 inch plus or minus.
 - 2. Before pumping is started, prime the delivery pipe or hose by pumping mortar through the line using 5 gallons of mortar for each 50 feet of delivery pipe. Do not deposit mortar in the forms.

3.7 SURFACE FINISHES:

Add the following items to the end of Section 303.03.S, "Surface Finishes":

A. Form Tie Holes Patching: The surface form tie holes in the wall surfaces shall be roughened or abrasion blasted and cleaned, the tie holes shall then be coated with a water insensitive epoxy or an acceptable bonding agent and properly filled by damp-packing with a mortar of drypack consistency. The mortar shall have a mix of one part of cement to one-part sand ratio. The amount of added water to the cement-sand mix shall be such that the mortar can be driven into the voids and will compact properly. The outside tie holes shall not be drypacked any sooner than 7 days after the inside holes have been drypacked.

B. Reservoir Concrete Finishes Schedule

1. Reservoir floor: Wood-float surface conforming to specified slope.
2. Top of Wood-float surface conforming to specified slope.
3. Reservoir wall, columns and outside edge of roof slab and wall footing:
See WSS Section 303.06.C.6.
4. Reservoir roof slab: The top surface shall receive a steel trowel finish which is subsequently swept with a steel or hard-bristled broom to leave a fine uniformly scratched concrete surface.

C. Wood-Float Finish

1. This finish requires an integral finish by wood-float after screeding, to compact the surface evenly.
2. Any excess surface water shall be removed before floating and no mortar shall be used for leveling.

D. Steel Trowel Finish

1. This shall be an integral finish obtained by trowelling with a steel trowel after the surface has been floated and allowed to stand until all water-sheen has disappeared.
2. Finish shall be an integral finish obtained by trowelling with a steel trowel after the surface has been floated and allowed to stand until all water-sheen has disappeared.

3. Cement, or mixture of cement and sand, shall not be spread on surfaces to absorb excess water or to stiffen the concrete.
4. Trowelling shall produce a dense, smooth, impervious surface free from defects and blemishes.

3.8 CURING COMPOUND:

- A. Curing compound shall only be allowed for non-reservoir concrete with the approval of the Department of Water Supply. Curing compound shall conform to ASTM C309. Application shall be as per manufacturer's printed instructions.

3.9 PROTECTING AND CURING:

Replace Section 303.03.R "Protecting and Curing" with the following:

- A. All fresh concrete shall be adequately protected from injurious action by the sun, heavy rains and mechanical injury and shall not be allowed to dry out from the time it is placed until the expiration of the minimum curing period specified here.
- B. For the reservoir, all horizontal, screeded and floated surfaces, exposed to drying winds and sunlight, shall be sprayed with a curing compound at an application specified by the manufacturer. After the surface is dry to the touch, a curing blanket consisting of at least 10 oz. burlap and 4 mil thick white opaque polyethylene in conformance with ASTM C-171, shall be carefully taped and sealed over the concrete surface and kept on such surface for as long as possible, but for at least 10 days, to minimize the loss of moisture trapped between the polyethylene and the concrete. The polyethylene covering will not be required for new wall construction.
- C. As an alternative to the two-step process described above a wet curing method as described in WSS Section 303.03.R can be used for at least 10 days.
- D. For the reservoir walls, all formed concrete surfaces shall be sprayed with a concrete curing compound immediately after the forms are removed at a coverage rate specified by the manufacturer. This requirement will be waived if the forms are left in place for at least 7 days.
- E. Prior to placing the reservoir in service or the surface is coated, the surfaces coated with curing compound shall be pressure blasted with water or abrasive to completely remove the compound.
- F. For concrete curing for structures other than reservoir concrete, in addition to the curing methods listed, the Contractor may use a curing compound that

complies with ASTM C-309 and is compatible with any paints or toppings to be applied. Wax-based curing compounds will not be permitted.

- G. The Manager reserves the right to reject concrete that was not provided with the specified curing.
- H. Delete the second sentence from the first paragraph in Section 303.12.A "Protection of Reservoir - General".

3.10 CONCRETE REPAIR:

- A. Defective surfaces, such as honeycomb, shall be cut out entirely until homogeneous concrete is met, even if it means going through the entire wall, floor or roof slab.
- B. Such areas shall be coated with a two-component, 100% solids, moisture-tolerant, NSF 61 conforming, high-modulus structural epoxy paste bonding material, such as Sikadur 31, Hi-Mod Gel by Sika, which shall be applied in accordance with the manufacturer's instructions, before damp-packing the area with a mix consisting of one part of Portland cement and two parts of sand and fine gravel, epoxy and sand mix, or any combination of materials and mixes as the situation dictates in the opinion of the Manager.
- C. The water content of the repair mortar material shall be such that a ball of the mix may be squeezed in the hand without bringing free water to the surface.
- D. Repair mortar material shall be tamped into place and finished to match adjacent concrete surfaces.
- E. If a patch is required to be applied in multiple lifts, an approved epoxy bonding agent shall be applied between lifts.
- F. Surfaces which have been damp-packed shall be kept continuously damp to cure for a period of not less than seven days after completing the damp-pack operation, by the curing procedure described below.
- G. Neither Embeco, calcium chloride or fast-setting cements/additives shall be used for filling honeycomb areas, nor shall they be mixed with damp-pack material. Contractor shall provide certification that any material placed on or in the concrete wall shall be free of chlorides and other materials corrosive to reinforcing steel.

3.11 EPOXY ADHESIVE INJECTION OF CONCRETE CRACKS:

- A. Repair Criteria: All cracks with a width of 0.015 inches or larger shall be repaired using this procedure.

- B. Epoxy injection shall be performed by a manufacturer trained and certified applicator.
- C. Contractor's/Subcontractor's operator engaged in the epoxy injection process shall have satisfactory operator experience in the methods of restoring concrete structures utilizing the specific epoxy injection process indicated. Operator's experience shall include previous repairs of cracked or damaged concrete structures, the technical knowledge of correct material selection and use, and the operation, maintenance and troubleshooting of equipment.
- D. Epoxy Resin Adhesive for Injection: Epoxy adhesive shall be 100% solids, 2-part water insensitive, low-viscosity epoxy resin. Epoxy shall be suitable for repairing both dry and damp cracks. Epoxy shall develop a minimum tensile strength (ASTM D695) of 6,000 psi and a minimum compressive strength of 8,000 psi (both at 28 days). Products meeting these requirements include SELECT BOND GP-4440, as manufactured by SPC, Costa Mesa, CA; SIKADUR 35, HI-MOD LV as manufactured by Sika Corp., Lyndhurst, NJ or approved equal.
- E. The crack surface seal material shall have adequate strength to hold injection fittings firmly in place and to resist injection pressures adequately to prevent leakage during injection. The material shall be compatible and from the same manufacturer as the epoxy resin adhesive product.
- F. Pressure Injection Equipment:
 - 1. The equipment used to meter and mix the two injection adhesive components and inject the mixed adhesive into the crack shall be portable, positive-displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at the nozzle. The pumps shall be electric or air powered and shall provide in-line metering and mixing.
 - 2. The injection equipment shall have automatic pressure control capable of discharging the mixed adhesive at any pre-set pressure up to 200 psi plus or minus 5 psi and shall be equipped with a manual pressure control override.
 - 3. The injection equipment shall have the capability of maintaining the volume ratio for the injection adhesive prescribed by the manufacturer of the adhesive within a tolerance of plus or minus 5 percent by volume at any discharge pressure up to 200 psi.
- G. Injection Equipment Pressure Test:
 - 1. The mixing head of the injection equipment shall be connected and the equipment run until clear uniformly mixed material flows into the purge

pail. The Operator shall engage the equipment shut-off nozzle valve and subsequently bump the on-off switch until the pressure reaches 200 psi. If pressure is maintained between 190-200 psi for one minute, check valves shall be considered to be functioning properly and the injection may proceed. If pressure drops below 190 psi, Contractor shall be required to have new seals installed on the check valves and the equipment shall be subsequently retested.

2. The pressure test shall be run for each injection unit at the beginning and after meal breaks of every shift that the unit is used.
3. The adequacy and accuracy of the equipment shall be solely the responsibility of the Contractor.

H. Mix Ratio Test:

1. The epoxy mixture ratio shall be monitored continuously while injecting by placing a strip of masking tape on the sides of the A & B reservoirs full height. After filling reservoirs, the A & B levels shall be marked and monitored while running injection machine into purge pail for a period of one minute. The difference in liquid height shall then be compared to verify the correct volume ration is being dispensed.
2. If the dispensing ratio is incorrect, the equipment shall be adjusted and retested.
3. The ratio test shall be run for each injection unit at the beginning and after meal breaks of every shift that the unit is used.

I. Proof of Mix Ratio Test:

1. At all times during the course of the work the Contractor shall keep complete and accurate records available to the Manager of the equipment pressure and mix ratio tests specified above.
2. In addition, the Manager at any time without prior notification of the Contractor, may request the Contractor to conduct the tests specified above in the presence of the Manager.

J. Injection Repair Preparation:

1. The substrate surface at the seal material application shall be clean, no dirt, dust, grease, oil, efflorescence or other foreign matter that may be detrimental to the integrity of the epoxy bond. Acids and corrosives shall not be permitted to be used.

2. Entry ports shall be placed along the crack spaced not more than the thickness of the concrete section to be repaired.
3. Surface seal material shall be applied to the face of the crack between the entry ports. For through cracks, surface seal shall be applied to both faces, where possible.
4. Surface seal material shall be allowed to cure to gain adequate strength before proceeding with pressure injection.

K. Epoxy Adhesive Injection:

1. Begin injection at lower entry port for vertical applications and at one end of the crack in horizontal applications, continuing until epoxy adhesive appears at the next entry port in line.
2. Epoxy injection shall progress along the crack to the next adjacent port where epoxy adhesive has appeared.
3. Epoxy adhesive injection shall be performed sequentially along the ports until cracks are completely filled.
4. If port-to-port travel of epoxy adhesive is not achieved, the work shall immediately be stopped and the Manager notified.

L. Finishing:

1. After cracks are completely filled, epoxy adhesive shall be cured to prevent any draining or runback of epoxy material from cracks.
2. Any surface seal material, injection ports and injection adhesive shall be removed from concrete surfaces.
3. The face of the crack shall be finished flush to the adjacent concrete surface showing no indentations or protrusions caused by the placement of entry ports.

PART 4 – PAYMENT

Payment will not be made directly but shall be included in the Lump Sum Bid of which it is a part. Such payment shall represent full compensation for furnishing all materials, labor, tools, equipment and incidentals required to complete the work.

END OF SECTION

SECTION 05500 – MISCELLANEOUS METALS FABRICATION

PART 1 – GENERAL

1.1 DESCRIPTION:

- A. Furnish of all labor, materials, tools and equipment necessary for completing metal item fabrication and installation complete covered in this specification.
- B. This section includes the following:
 - 1. Stainless Steel Interior Ladder
 - 2. Pre-Fabricated Stainless-Steel Fall-Prevention System
 - 3. Aluminum Railing
 - 4. Roof Access and Observation Hatches
 - 5. Overflow Pipe Supports
 - 6. Scupper Collector Box

1.2 SUBMITTALS:

- A. Provide product data for the following:
 - 1. Pre-fabricated ladder stainless steel fall protection system
 - 2. Structural adhesive for post installed anchorage
 - 3. Aluminum Railing
 - 4. Scupper Collector Box
- B. Shop Drawings: Detail fabrication and erection of each metal fabrication member indicated. Include plans, elevations, sections, and details of metal fabrication members and their connections. Show anchorage and accessory items.
- C. Calculations: Provide aluminum rail system manufacturer's calculations demonstrating the system capacity meets OSHA loading requirements.
- D. Provide templates for anchors and bolts specified for installation to be coordinated with other work.

- E. Manufacturer's installation instructions and rough-in dimensions for manufactured items.
- F. Welding Certificates: Copies of certificates for welding procedures and personnel.
- G. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.3 QUALITY ASSURANCE:

- A. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units within the project schedule.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.6, "Structural Welding Code—Stainless Steel."
 - 3. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.4 DELIVERY, STORAGE, AND HANDLING:

- A. Exercise proper care in handling of Work so as not to damage finished surfaces. Protect Work from damage after it is in place.
- B. Store materials under cover in a dry and clean location off the ground in manner that will not distort and bend assembly. Remove materials that are damaged or otherwise not suitable for installation from job site and replace with acceptable materials at no additional cost to DWS.

1.5 PROJECT CONDITIONS:

- A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.6 COORDINATION:

- A. Coordinate installation of anchorages for metal fabrications, ladders and railing. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete. Deliver such items to Project site in time for installation.

1.7 SCHEDULING:

- A. Schedule installation of ladders and railings for mounting to occur only to completed concrete construction with required curing time. Do not support temporarily by any means that does not satisfy structural performance requirements.
- B. Scheduling painting of existing elements to be painted prior to installation of new work that will conceal or make the surface inaccessible.
- C. If epoxy anchors are installed, Contractor shall arrange for special inspection for their installation. Deputy inspector's report shall be submitted to the Manager.

PART 2 – MATERIALS

2.1 MATERIALS

- A. Structural Steel Plate or Angle Shapes: ASTM A36, unless noted otherwise.
- B. Stainless Steel Bars and Shapes: ASTM A276, Type 316, unless noted otherwise.
- C. Stainless Steel Sheets, Strip, and Plates: ASTM A666, Type 316, unless noted otherwise.
- D. Stainless Steel Pipes: ASTM A312, Grade TP 316, unless noted otherwise.
- E. Stainless Steel threaded rod or headed bolts: ASTM F593 (AISI 316).
- F. Stainless Steel nuts shall be Type 316 conforming to ASTM F594 with Teflon-coated hex nuts, where indicated, with flat washers.
- G. Aluminum Railing:
 - 1. The aluminum railing shall be constructed of pipes joined together with component fittings. Posts and railing shall be a minimum of 1 ½"

schedule 40 aluminum pipe, alloy 6063-T6 or 6015-T5, ASTM B 429 or B 221.

2. Components for aluminum railing that are glued or pop-riveted at the joints will not be acceptable. All components shall be cast from ANSI 713 alloy, high-tensile aluminum-magnesium alloy 535 (ASTM B26) and must be mechanically fastened with stainless steel hardware.
3. Welded finish shall be Aluminum Association M10C22A41 (215-R-1) clear anodized. The pipe shall be plastic wrapped. The plastic wrap shall be removed after erection.
4. Acceptable Aluminum Component Products:
 - a. "Series 500" by Superior Aluminum Products, Russia, OH (937-526-4065), (www.superioraluminum.com)
 - b. "TUFRAIL" by Thompson Fabricating Company, Birmingham, AL (205-841-0441), (www.tfco.com)
 - c. "Speed-Rail" by Hollaender Manufacturing Co., Cincinnati, OH (800-772-8800), (www.hollaender.com)
 - d. Approved equal
- H. Hot-dipped Galvanizing: Where galvanized steel rolled pressed and forged shapes, plates, bars, and strips are specified, the steel shall be galvanized in conformance with ASTM A123, unless noted otherwise. Galvanizing of steel hardware (bolts, nuts, etc.) shall be in conformance with ASTM A153, unless noted otherwise.
- I. Welding Rods and Filler Metal: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items. Select according to AWS specifications for metal alloy welded.
- J. Non-shrink, Non-metallic Grout: Factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for exterior applications.
- K. Structural Adhesive Epoxy: Factory-packaged, two-component, non-shrink, low-odor, 100% solids epoxy-based adhesive for use as a structural adhesive with a current ICC Evaluation Services, ES Report for both cracked and uncracked concrete, such as Simpson "SET-XP" or Hilti "HIT RE 500-SD" or approved equal.

- L. Zinc-rich Cold Galvanizing Coating: Coating shall contain a minimum of 92% zinc by weight after drying and designed for spot-priming damaged galvanized surfaces.
 - 1. Products such as Galvax by Alvin Products, Everett, MA (www.alvinproducts.com) or Z.R.C. by ZRC Worldwide, Marshfield, MA (www.zrcworldwide.com) meet the above requirements or approved equal
- M. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D 1187.
- N. The roof hatch assembly and frame shall conform to subsection "D.3" of the WSS, Section 303.22 and the following:
 - 1. The neoprene gasket between the cover and the frame shall be continuous without any gaps. Secure gasket with thread stud that is welded to edge frame by installing gasket over thread stud and secure in place with nut.
 - 2. The roof hatch hinges shall have a solid, continuous stainless-steel hinge pin for the entire length of the hinge. The hinge pipe over the hinge pin shall consist of a series of stainless-steel pipe sections. The pipe sections shall be welded alternately to the hinge cover frame and cover. At each end of the hinge the hinge pin shall be welded to the hinge pipe which in-turn is welded to the cover. As part of the hinge assembly, the rod shall be coated with industrial-grade grease prior to installation.

2.2 STAINLESS STEEL LADDER:

- A. Fabricate ladder for location shown, with dimensions, spacing, details, and anchorages as indicated and in accordance with WWS Section 303.22.G.
- B. Siderails: Continuous stainless-steel pipe section, size and spaced as indicated on Drawings.
- C. Bar Rungs: 3/4-inch minimum diameter solid steel bars, spaced 12 inches on center. Provide non-slip surfaces on top of each rung by coating with abrasive material bonded to rung by a proprietary process designed for use in potable water or the surface can be knurled to provide a slip-resistant textured surface.
- D. Fit rungs in centerline of side rail pipes; insert rung 1 inch minimum into pipe section; fillet weld circumference of rung.
- E. Support ladder at top and bottom as detailed on Drawings.

- F. Measure existing conditions to provide connection plates and ladder of proper length and orientation to properly fit. Verify fit-up before installing epoxy anchors.
- G. After ladder position is plumb and straight, the drilled and epoxy anchors shall be installed to anchor the ladder as shown in the Drawings.
- H. Form and cast concrete ladder base pad onto roughened surface coated with concrete bonding agent after the ladder has been secured to the roof slab.
- I. Concrete base pad to properly cure before utilizing the ladder.

2.3 FASTENERS:

- A. General: Provide Type 316 stainless-steel fasteners or as specified on construction documents.
- B. Bolts and Nuts: Type 316 stainless steel hexagon-head bolts, ASTM F597 with Teflon-coated hex nuts, ASTM F 597, where indicated, flat washers.
- C. Lock Washers: Helical, spring type, stainless steel.
- D. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

2.4 RESERVOIR ROOF ACCESS HATCH:

- A. Material shall be 6061-T6 aluminum for bars, angles and extrusions, 1/4" diamond plate shall be 5086 aluminum.
- B. Unit to be constructed per AWWA Standard for tank openings stating, "Hatches should be constructed as to prevent leakage into the tank and locked to resist unauthorized entry and vandalism." Shall be constructed to eliminate infiltration of pests into water storage tanks.
- C. Covers shall be turn down 2" over curb (4" tall angle frame). Angle Frame shall be of extruded aluminum with an integral seat. Angle frame shall be a minimum 4" tall and 1/4" thick.
- D. Covers shall be equipped with a hold open arm. Door shall lock open in the 90-degree position. Each hold open arm shall be fastened to the frame with a 1/2" grade 316 stainless steel bolt.

- E. All hardware shall be stainless steel. Each hatch shall be supplied with an exposed padlock clip for owner's padlock.
- F. Unit supplied with "Rimseal" gasket on vertical leg of angle. "Rimseal" to be pressed tightly against cover by aluminum pressure locks (swing bolts).
- G. Doors balanced to require less than 30 lbs opening force.
- H. Install graphite pad and silicone gasket between frame and concrete.

PART 3 – EXECUTION

3.1 STEEL FABRICATION - GENERAL

- A. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use only welded connections for steel member connections. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate metal items to comply with indicated dimensions, member sizes and spacing, details, finish, and anchorage.
- C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work. Shear and punch metals cleanly and accurately. Remove burrs.
- D. Welded Connections: Fabricate railing by welding members. For all welded connections, cope components at perpendicular and skew connections to provide a close fit. Weld connections continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
 - 5. Fabricate joints in a watertight manner.
 - 6. Form work true to line and level with accurate angles and surfaces and straight sharp edges.

7. Remove sharp or rough areas on exposed traffic surfaces. Close exposed ends of railing members with fitted and welded ends.
8. Railing connections shall not require any field welding or rivets for assembly.

3.2 GALVANIZING:

- A. Components specified as galvanized, shall be in accordance with ASTM A123 and all applicable documents listed herein.
- B. Where fabricated pieces are too large to be galvanized as a single unit, the fabricated piece may be broken down into smaller units to be welded or bolted together after galvanizing. The location of all added connections must be clearly identified as such on a shop drawing submitted to the Manager for approval.
- C. Galvanizing shall be repaired at all locations of welding in accordance with methods A1 or A3 of ASTM A780.
- D. Repairs of other defects such as those caused by inadequate surface preparation, failure to remove weld slag, rough welding, poor galvanizing practice or defects due to any other causes shall only be accepted or approved by the Manager after inspecting the item after delivered to the jobsite.

3.5 FALL-PREVENTION SYSTEM:

- A. The fall prevention system to be mounted on ladders where specified on the Drawings, shall be a manufactured item. The manufacturer shall have a minimum of 10 years of experience manufacturing the product provided for this project. The system shall meet the requirements of OSHA requirements of Standards 29 CFR, Part 1910.27(d)(5) and 1926.1053.
- B. The fall prevention system shall be constructed from stainless steel, the same material as the ladder.
- C. The fall prevention system shall consist of a vertical 3/8-inch minimum diameter flexible cable with a shock-absorbing top bracket and tension indicating bottom bracket serving as the anchors for the steel cable which runs the full length of the ladder. The top bracket shall be designed to telescope upward from a position close to the top rung of the ladder to a height three feet above the top rung when the hatch cover is open.
- D. A swiveling cable sleeve shall be designed to prevent falls by locking onto the cable. It shall be designed to be attached or removed from the cable

anywhere along the cable and automatically follow as one climbs or descends.

- E. Three woven nylon safety harnesses with an integrated belt design to attach to the cable sleeve shall be provided as part of this contract. The harnesses shall be adjustable and include front and back "D" rings and padded straps and three cable sleeves.
- F. The system shall be designed to be installed to a metal ladder with standard wrenches, with cable guides designed to allow a person to ascend or descend unhindered and shall be equipped with a built-in cable tensioner to indicate when the system is at the proper cable tension.
- G. The fall protection system shall be installed and inspected in accordance with the manufacturer's installation manual.
- H. Product information describing the components and features of the proposed system shall be provided to the Engineer for review.
- I. Product and Manufacture:
 - 1. 'Lad-Saf' ladder safety system by DBI/SALA, Red Wing, MN (800) 328-6146, www.salagroup.com
 - 2. 'Miller Transcendor Cable Climbing System' by Honeywell Miller, Franklin, PA (800) 873-5242
 - 3. Approved equal

3.6 RAILING INSTALLATION

- A. Provide railing in a timely manner, not to delay progress of construction.
- B. Perform cutting, drilling, and fitting required for installing railing as shown on Contract Drawings. Install members accurately in location, alignment, and elevation; with posts, rails level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
- D. Railing post bases to be installed on leveling grout (if required), after railing is properly located for installation, bases shall be secured as detailing in Project Drawings.
- E. Railing to be bolted into place with drilled and epoxy anchors shall be plumbed and leveled and secured in place prior to installation of anchors. Anchors shall be installed per installation requirements of product's ICC

Research Report. All epoxy anchors require special inspection by deputy inspector during installation.

3.7 ROOF ACCESS HATCH AND FRAME INSTALLATION:

- A. Install miscellaneous specialties as indicated on the drawings. The cover frame shall be installed flush with the concrete surface.

3.8 DISSIMILAR METAL SEPARATION:

- A. For member-to-member contact, provide two layers of separation tape between dissimilar metals.
- B. For fasteners of dissimilar metal relative to the base material, provide insulating washers under nuts and bolt or screw heads designed to separate dissimilar metals.

PART 4 – PAYMENT

Payment will not be made directly but shall be included in the Lump Sum Bid of which it is a part. Such payment shall represent full compensation for furnishing all materials, labor, tools, equipment and incidentals required to complete the work.

END OF SECTION

SECTION 05600 – ALUMINUM STAIRS

PART 1 – GENERAL

1.1 DESCRIPTION:

- A. Furnish of all labor, materials, tools and equipment necessary to complete the industrial type aluminum stair structural framing, grating treads, including security enclosure, in place complete as shown on the drawings, as specified herein, and as needed for a properly functioning installation.

1.2 SUBMITTALS:

- A. Manufacturer's product data, including properties, installation instructions and limitations to prove compliance with the specified requirements.
- B. Shop Drawings Fabrication shop drawings indication member sizes, assembly, connection details, fasteners, layout, installation, anchorage, and interface of the work of this section with the work of adjacent trades.
- C. Submit complete and detailed list of materials proposed for security fencing, including connection hardware, their installation instructions and certification the proposed products meet the project requirements.
- D. Samples: Submit samples of security fencing mesh with powder coating finish demonstrating the color, texture and appearance of the mesh proposed to be provided for approval by the Manager before ordering materials. Submit as many samples as required to secure approval from the Manager. Colors shall be as scheduled hereinafter.

1.3 QUALITY ASSURANCE

- A. Comply with OSHA and local building codes.
- B. Bar Grating Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with no less than three years of experience.
- C. The fencing manufacturer shall provide certification the company has been manufacturing the proposed product for at least the last five (5) years.
- D. Fencing manufacturer's representative shall be available to be on-site during the installation of the fencing to answer questions or provide installation guidance for atypical site conditions in accordance with the manufacturer's directions and in no way negate the manufacturer's warranty.

- E. Comply with recommendations of AWS, Structural Welding Code on Aluminum, D1.2 latest edition.
- F. Stair shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform Load: 100 pounds per square foot.
 - 2. Concentrated Load: 300 pounds applied on an area of 4 square inches at any location on a stair tread.
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.
 - 4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
 - 5. Limit deflection of treads, platforms, and framing members to $L/360$ or $\frac{1}{4}$ -inch, whichever is less.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver all materials to job site properly marked to identify the structure for which they are intended and at such intervals to insure uninterrupted progress of the work. Marking shall correspond to markings indicated on the shop drawings.
- B. Store all members and materials off the ground using pallets, platforms, or other supports, but does not result in twisting or distorting the members.
- C. Do not store materials on the structure in a manner that might cause distortion or damage to the members of the supporting structure.

1.5 GENERAL REQUIREMENTS

- A. Fit and shop assemble stair in the largest practical sections for delivery to the job site.
- B. Miter the stringers at changes in direction with joints tightly fitted and secured by continuous welds and grind with #3 NOMMA Finish. Make exposed joints butt tight. Ease exposed edges to a small uniform radius.
- C. Close and fit the ends of stringers at the landing surface. Position stringer to locate the top stair tread at the same rise height from the finished landing surface as the tread-to-tread rise height on the stair.

PART 2 – MATERIALS

2.1 ALUMINUM:

- A. Plate: Alloy 6061-T6, Mill Finish, Heat Treatable.
- B. Structural Shapes: Alloy 6061-T6, ASTM B 308
- C. Sheet Aluminum: ASTM B209 (ASTM B209M), Alloy 5052, H32 or H22 Temper.
- D. Round Pipe: Alloy 6061-T6, ASTM B429
- E. Square Tubing: Alloy 6063-T52, Extruded
- F. Rectangular Tubing: Alloy 6063-T52, Extruded
- G. Aluminum- Alloy Bars: ASTM B211 (ASTM B211M), Alloy 6061-T6

2.2 ALUMINUM BAR GRATING:

- A. Material: ASTM B 211, Alloy 6061-T6 or 6063-T6
- B. Construction Type: Swage-Locked, Standard Rectangular Bar, bearing bars shall be spaced 1-3/16-inches on center and cross bars shall be spaced at 4-inches on center. Cross bars shall be flush at top with bearing bars.
- C. Surface: Serrated
- D. All Grating edges shall be banded.
- E. Unless noted other, all bar grating landings shall not be welded to supports, provided saddle clips as required for attachment. Limit weight of each grating section to no more that 50-pounds.
- F. Aluminum Bar Grating Stair Treads: Provide standard prefabricated aluminum grating treads and aluminum nosings with extruded re-enforced profile with non-slip ribs. Mechanically fasten grating treads with aluminum bearing angle to stringers.

2.3 ALUMINUM HANDRAILS:

- A. See Section 05500 - Miscellaneous Metal Fabrications for material requirements.

2.4 ALUMINUM FINISHES:

- A. Grind weld joints smooth with adjacent finish surface.
- B. Coat aluminum in contact with dissimilar metals, concrete or mortar products with one-coat of bituminous paint.

PART 3 – EXECUTION

3.1 STAIR FRAMING INSTALLATION:

- A. Install metal stair treads in accordance with the manufacturer's recommendations and approved shop drawings.
- B. Install components plumb and level, accurately fitted, free from distortion or defects.
- C. Securely bolt or anchors, plates, angles, hangers, and struts required for connecting stairs to reservoir.
- D. Provide welded field joints where specifically indicated or shop drawings. Perform field welding in accordance with the appropriate AWS Specification.
- E. Obtain approval prior to site cutting or creating adjustments not scheduled.

3.2 STAIR HANDRAILING INSTALLATION:

- A. Rail components used shall be as recommended by manufacturer for stair handrail application.
- B. Rail posts shall be secured to the top of the stair stringer member with base component specifically designed for stair handrails.
- C. Provide termination of handrail in compliance with OSHA requirements for industrial stair application.

3.3 EXPANDED METAL SECURITY FENCING

- A. General: This item of work shall include the furnishing of labor, materials and appurtenances, tools, and equipment necessary for completing installation of the security fencing at the base of the exterior stairs in general conformance with Section 303.33 of the Water System Standards, dated 2002, and specifically as supplemented hereinafter, and applicable to this project.
- B. Materials:

1. Security Mesh Panels: Fencing mesh shall be a 9-gauge standard expanded carbon steel metal mesh with a 3/4-inch mesh short width hole size. The panel size shall be the standard 48 inches wide by 108 inches tall, as required to provide an eight-foot fence height with a one-foot fence extension beneath grade to serve as an anti-burrowing measure. The mesh shall have a powder-coating consisting of a preparation media blast of the metal prior to one coat of polyester powder. The color of the powder coating shall be the standard green. Mesh orientation shall be confirmed by the Manager before ordering materials.
2. Examples of products that meet these requirements are:
 - a. Securex Diamond Expanded Metal Fence System: by Niles Fence & Security Products, LLC, Niles, OH (800) 321-7464 [www.nilesfence.com]
 - b. Approved equal
3. Fence Framework: Fence line posts, end posts, and horizontal rails shall be the size and length and installed at the specified spacing and locations as indicated on the Project Drawings and per the manufacturer's specifications for an 8-foot high fence, whichever is more stringent. The posts and rails shall be finished using the same powder-coating color and finish as the fence mesh. The fence enclosure shall be constructed with three horizontal rails.
4. Fence Attachment Fittings and Hardware: All the necessary clips, clamps, fittings, bracing members, post caps, tension rods, anchors and other accessories required for a complete fence installation shall be hot-dipped galvanized and sized to framework specific to an 8-foot high fence, installed as specified by the fencing manufacturer.
5. Fasteners: Nuts and bolts shall be stainless steel carriage bolts with breakaway nuts to maximum security. Bolt size and length shall be per the manufacturer's specifications. All nuts and bolts shall be painted to match the fence mesh and framework after installation.
6. Gate: The fence gate shall be constructed of the same or similar materials as the fence. Fence gate shall be a single swing pedestrian gate with the gate frame consisting of round pipe fully welded with fittings, hinges, and accessories (i.e. truss rod, tighteners, post caps, brackets, etc.) structurally capable of supporting the gate and providing smooth working operation. The swing gate shall be covered with the Securex mesh fabric and shall fit flush on all sides of the gate frame allowing no open spaces between the fabric and the gate frame. Contractor shall coordinate with the gate manufacturer to install detailed lock box on fencing gate frame.

7. Security Appurtenances:

- a. Barbed wire shall be 4-point using 12½ gauge twisted galvanized steel wire. Barbed wire support arms shall be designed to fit on top of the fence posts and the top of the gate frame using the manufacturer's approved method of attachment and installation methods.

C. Security Fencing Installation:

1. Do not begin fence installation until the reservoir stairs have been properly constructed and installed.
2. Preparation: The post locations shall be laid out within the maximum recommended spacing as indicated on the drawings or specified by the manufacturer. Make any adjustment to the post locations, if necessary, in order to provide the most efficient post layout for the application following the manufacturer's installation recommendations.
3. Provide the recommended size of fence post, noting the increased size at corners and termination (gate) points in the fence. The post shall be set on center and within ½-inch plumb for the full height of the post or as specified by the manufacturer, whichever is less. Consolidate the concrete and crown the top to keep water from ponding on the post footing.
4. Assemble the fence rails and attach the expanded metal mesh as recommended by manufacturer to provide a taut, secure installation. Provide the required mesh overlap and connections, anchors and clips at corners and termination posts for a complete system as per the manufacturer's instructions.
5. Install gate where indicated on Drawings. Adjust gate hinge connections as necessary in order to have a level, smooth operating gate. Install gate stops in a location that will hold the gates a minimum of 90 degrees open.
6. Install three strands of barbed wire with use of angled support arms installed to bend away from the stairs – see fencing details in Drawings. Install three strands of barbed wire on top of fencing and gates with support arms straight up if the bent arms will impede the swing of the gate. The barbed wire shall be taut, straight and secure.

PART 4 – PAYMENT

No separate payment for will be made; compensation for such work shall be deemed to be included in the Lump Sum Bid for the item of which it is a part.

END OF SECTION

SECTION 06600 – FIBERGLASS REINFORCED POLYMER (FRP) PRODUCTS AND
FABRICATION

PART 1 – GENERAL

1.1 DESCRIPTION:

- A. This item of work shall include the furnishing of all labor, materials, tools and equipment necessary for the fabrication and installation work of Fiberglass Reinforced Polymer (FRP) products, in place complete, as specified hereafter and in accordance with the project drawings.

1.2 SUBMITTALS:

- A. Shop drawings of all fabricated pultruded or molded gratings and appurtenances shall be submitted to the Engineer for approval. Show anchorage and accessory items.
- B. Product data, dimensions and spacing of elements and installation directions for manufactured items.
- C. Performance Data, span and load tables for the proposed grating product indicating the calculated live load deflection based on span and 100 psf live load.
- D. Qualification Data: The material covered by these specifications shall be furnished by an ISO-9001:2000 certified manufacturer of proven ability who has regularly engaged in the manufacture and installation of FRP systems.

1.3 QUALITY ASSURANCE:

- A. Fabricator Qualifications: Firm experienced in successfully producing FRP fabrications similar to that indicated for this project, with sufficient production capacity to produce required units without causing delay in the work.

1.4 DESIGN CRITERIA:

- A. The design of FRP products including connections shall be in accordance with governing building codes and standards and OSHA regulations as applicable.
- B. Design live loads of FRP gratings shall not be less than 100 psf uniformly distributed unless specifically stated otherwise in drawings and/or supplementary conditions. Grating deflection at the center of a simple span is not to exceed 0.25".

1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Exercise proper care in handling of Work so as not to damage finished surfaces. Protect Work from damage after it is in place. Store materials off the ground and in a manner that does not deform Work under its own weight. Remove materials that are damaged or otherwise not suitable for installation from job site and replace with acceptable materials at no additional cost to DWS.
- B. Grating shall be shipped from the manufacturer, palletized and banded with exposed edges protected to prevent damage in shipment.
- C. All FRP shall be stored before, during, and after shipment in a manner to prevent cracking, twisting, bending, breaking, chipping or damage of any kind to the materials or equipment, including damage due to over exposure to the sun. Any material which, in the opinion of the owner, has become damaged as to be unfit for use, shall be promptly removed from the site of work, and the Contractor shall receive no compensation for the damaged material or its removal.
- D. Where FRP fabrications are indicated to fit other construction, verify dimensions by field measurements before fabrication and indicate these measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 – MATERIALS

2.1 GENERAL:

- A. Materials used in the manufacture of the FRP products shall be raw materials in conformance with the specification.
- B. All FRP products noted herein shall be manufactured using a pultruded process utilizing polyester ester resin with flame retardant and ultraviolet (UV) inhibitor additives. A synthetic surface veil shall be the outermost layer covering the exterior surface. The flame retardant FRP shapes shall achieve a flame spread rating of 25 or less in accordance with ASTM test method E-84.
- C. If required, after fabrication, all cut ends, holes and abrasions of FRP shapes shall be sealed with a compatible resin coating.
- D. All exposed surfaces shall be smooth and true to form.

2.2 PULTRUDED GRATING:

- A. The bearing bars shall be joined into panels by passing continuous length fiberglass pultruded cross-rods through the web of each bearing bar. A

continuous fiberglass pultruded bar shaped section shall be wedged between the two cross rod spacers mechanically locking the notches in the cross-rod spacers to the web of the bearing bars. Continuous chemical bonding shall be achieved between the cross-rod spacers and the bearing web and between the bar shaped wedge and the two cross rod spacers locking the entire panel together to give a panel that resists twist and prevents internal movement of the bearing bars.

- B. The top surface of all grating and treads shall have a non-skid grit affixed to the surface by an epoxy resin followed by a top coat of epoxy resin. Color shall be high visibility yellow.
- C. Grating shall be fabricated to the sizes shown on the drawings.
- D. Hold down clamps shall be type 316L stainless steel insert hold downs as provided by manufacturer. Use 2 at each support with a minimum of 4 per grating panel.
- E. All bearing bars that are to be exposed to UV shall be coated with polyurethane coating of a minimum thickness of 1 mil.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages. Coordinate delivery of such items to project site.
- B. Fastening to in-place construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous FRP fabrications to in-place construction; all fasteners shall be type 316 stainless steel, unless noted otherwise.
- C. Cutting, fitting and placement: Perform cutting, drilling and fitting required for installation of miscellaneous FRP fabrications. Set FRP fabrication accurately in location, alignment and elevation; with edges and surfaces level, plumb, true and free of rack; measured from established lines and levels.
- D. All field cut and drilled edges, holes and abrasions shall be sealed with a catalyzed resin compatible with the original resin as recommended by the manufacturer.
- E. Grating shall be installed to bear evenly on supports and shall not rock after anchored to supports. Follow manufacturer's recommendations for installation and joint gap tolerance of grating panels.

PART 4 – PAYMENT

No separate payment for will be made; compensation for such work shall be deemed to be included in the Lump Sum Bid for the item of which it is a part.

END OF SECTION

SECTION 07500 – FLUID-APPLIED ROOFING SYSTEM

PART 1 – GENERAL

1.1 DESCRIPTION:

- A. Furnish of all labor, materials, tools and equipment necessary for the complete installation of fully reinforced cold fluid-applied polymethyl methacrylate (PMMA) liquid resin roofing membrane and membrane flashing system where indicated on the drawings.
- B. This section includes the following:
 - 1. Adhered cold liquid-applied reinforced waterproofing system including, membrane, penetration flashings, base flashings, expansion joints, and non-skid finish.
 - 2. Substrate preparation, cleaning, after leveling and patching.
 - 3. Waterproofing membrane installation.
 - 4. Flashing installation and expansion joint installation.

1.2 REFERENCES:

- A. American Society for Testing and Materials (ASTM) ASTM C 836 Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane
- B. National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual
- C. American Concrete Institute (ACI) ACI-308 - Recommended Practice for Curing Concrete
- D. ASTM - D638 - Test Methods for Tensile Properties of Plastics
- E. ASTM - D4258 - Standard Practice for Surface Cleaning Concrete for Coatings
- F. ASTM - D4259 - Standard Practice for Abrading Concrete
- G. ASTM - D4541 - Method for Pull-Off Strength of Coatings using Portable Adhesion Tester
- H. ASTM - E96(A) - Test Methods of Moisture Transmission of Material

- I. ASTM E-108, ANSI/UL 790 for fire resistance
- J. Steel Structures Painting Council (SSPC)

1.3 SUBMITTALS:

- A. Roofing System Product Data: Provide current standard printed product literature indicating characteristics of membrane materials, flashing materials, components, and accessories, product specification, and installation.
- B. Product Samples: Submit product samples of membrane and flashing materials showing color, texture, thickness and surfacing representative of the proposed system for review and approval by Manager.
- C. Submit sample copies of both the Manufacturer and Applicator warranties for the periods stipulated. Each specimen must be a preprinted representative sample of the issuing company's standard warranty for the system specified.
- D. Submit copies of current Material Safety Data Sheets (MSDS) for all components of the work.
- E. Submit documentation from the roofing system manufacturer to verify contractor's status as an approved applicator for warranted installations.
- F. Roofing System Shop Drawings: Submit shop drawings of cold liquid-applied reinforced unsaturated polyester showing a project plan, size, flashing details, and attachment for review and approval by the Manager and roofing system manufacturer.
- G. Provide certificates for the following;
 - 1. Roofing System Manufacture: Manufacture has been manufacturing product specified for the past 10-Years.
 - 2. Roofing Contractor: Provide list of projects, including address, contact information, type of products installed and square footage.
- H. Contractors performing repair work on the reservoir must take every precaution necessary to preserve the water quality of the reservoir. Contractor shall submit a plan of work procedures that will prevent debris, dust, and other airborne particles from entering the reservoir for the approval by the Manager.

1.4 QUALITY ASSURANCE:

A. Roofing System Manufacturer: Company specializing in manufacturing the products specified in this section with ten (10) years documented experience.

1. Submit the following certificate when making substitution request.

a. Roofing System Manufacture: Manufacturer has been manufacturing proposed product for the past 10-Years.

B. Applicator: Company specifically trained in performing the work of this section with (3) years documented experience and approved by system manufacturer for warranted membrane installation. Applicator shall submit the following certification for review:

1. Applicator shall submit documentation from the roofing system manufacturer to verify contractor's status as an approved applicator for warranted installations.

C. Calculate moisture content of substrate materials. Contractor shall determine substrate moisture content through-out the work and record with Daily Inspection Reports or other form of reporting acceptable to the Manager or designated representative, and roofing system manufacturer representative.

D. Random tests to determine tensile bond strength of membrane to substrate shall be conducted by the Contractor at the job site using an Elcometer Adhesion Tester Model 106 or similar device, or by the performance of a manual pull test. Contractor shall perform tests at the beginning of the Work, and at intervals as required to assure specified adhesion with a minimum of three (3) tests per 5000 square feet. Smaller areas shall receive a minimum of three (3) tests. Test results shall be submitted to the Manager and the roofing system manufacturer representative. Contractor shall immediately notify the Manager and roofing system manufacturer in the event tensile bond test results are below specified values.

1. Adequate surface preparation will be indicated by tensile bond strength of membrane to substrate greater than or equal to 116 psi.

2. Adequate surface preparation will be indicated by 135□ peel bond strength of membrane to substrate such that cohesive failure of substrate or membrane occurs before adhesive failure of membrane / substrate interface.

3. In the event the tensile bond strengths are lower than the minimum specified, additional substrate preparation is required. Repeat testing to verify suitability of substrate preparation.

- E. Contractor to monitor quantities of installed materials such as application of resin mixture, reinforcing fleece and flashing. Perform Work in accordance with manufacturer's instructions.
- F. Mock-up areas shall be used to determine required methods and tools to obtain degree of substrate preparation required by the roofing system manufacturer. Conduct tests as required above to verify that substrate preparation meets specified requirements. Tests shall include, but are not limited to, tensile bond strength and moisture content of substrate.
 - 1. Prepare and clean a three (3) foot by three (3) foot area of each substrate material type.
 - 2. Submit findings in writing to Manager and roofing system manufacturer.
 - 3. Mock-up areas shall be maintained for quality control for the entire project.

1.5 REGULATORY REQUIREMENTS:

- A. Conform to applicable building and jurisdictional codes for roofing/waterproofing assembly and fire resistance requirements.
- B. Comply with requirements of OSHA, NIOSH or local governing authority for workplace safety.

1.6 PRE-INSTALLATION MEETING:

- A. Convene a pre-installation meeting at the job site one (1) week before starting work of this section. Require attendance of parties directly affecting work of this section, including but not limited to, Manager, Roofing Contractor, and Roofing system Manufacturer's Representative. Review roofing/waterproofing preparation and installation procedures, mock-up installation location, coordination and scheduling required with related work, and condition and structural loading limitations of deck/substrate.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. The Contractor, together with the Manager, shall define a storage area for all components. The area shall be cool, dry, out of direct sunlight, and in accordance with manufacturer's recommendations and relevant regulatory agencies. Materials shall not be stored in quantities that will exceed design loads, damage substrate materials, or hinder installation or drainage.

- B. Store solvent-bearing solutions, resins, additives, inhibitors or adhesives in accordance with the MSDS and/or local fire authority. After partial use of materials replace lids promptly and tightly to prevent contamination.
- C. Roll goods shall be stored horizontally on platforms sufficiently elevated to prevent contact with water and other contaminants. DO NOT use rolls which are wet, dirty or have damaged ends.
- D. Roofing materials must be kept dry at all times. If stored outside, raise materials above ground or roof level on pallets and cover with a tarpaulin or other waterproof material. Plastic wrapping installed at the factory should not be used as outside storage covers.
- E. Follow manufacturer's directions for protection of materials prior to and during installation. Do not use materials which have been damaged to the point that they will not perform as specified. Fleece reinforcing materials must be clean, dry and free of all contaminants.
- F. Copies of all current MSDS for all components shall be kept on site. Provide any and all crew members with appropriate safety data information and training as it relates to the specific chemical compound he or she may be expected to deal with. Each crew member shall be fully aware of first-aid measures to be undertaken in case of incidents. Comply with requirements of OSHA, NIOSH or local governing authority for workplace safety.

1.8 ENVIRONMENTAL REQUIREMENTS:

- A. Do not apply roofing membrane during or with the threat of inclement weather.
- B. Application of cold liquid-applied reinforced unsaturated polyester roofing membrane may proceed while air temperature is lower than 95°F providing the substrate is a minimum of 5°F above the dew point.
- C. Ensure that substrate materials are dry and free of contaminants. DO NOT commence with the application unless substrate conditions are suitable. Contractor shall demonstrate that substrate conditions are suitable for the application of the materials, including the vapor drive pressure at the time of installation.

1.9 COORDINATION AND PROTECTION:

- A. Coordinate the work with the installation of associated metal flashings, accessories, appurtenances, etc. as the work of this section proceeds.
 - 1. Building components shall be protected adequately (with tarp or other suitable material) from soil, stains, or spills at all hoisting points and areas

of application. Contractor shall be responsible for preventing damage from any operation under its Contract. Any such damage shall be repaired at Contractor's expense to the owner's satisfaction or be restored to original condition.

2. Provide barricades, retaining ropes, safety elements (active/passive) and any appropriate signage required by OSHA, NIOSH, and NSC and/or the Manager.
3. Protect finished roofing membrane from damage by other trades. Do not allow waste products containing petroleum, grease, acid, solvents, vegetable or mineral oil, animal oil, animal fat, etc. or come into direct contact with the membrane.

1.10 WARRANTY:

- A. Manufacturer's Premier Warranty: Provide (20) year manufacturer's premier warranty under provisions of this section. This warranty provides for cost of labor and materials for loss of water tightness, limited to amounts necessary to effect repairs necessitated by either defective material or defects in related installation workmanship, with no dollar limitation ("NDL").
- B. Waterproofing Contractor's Warranty: Provide 2 year "Applicator Maintenance Warranty" covering workmanship for all work of this section including installation of membrane, flashings, metal work, and waterproofing accessories.
- C. Submit (2) executed copies of both the manufacturer and applicator warranties for the periods stipulated, starting from the date of substantial completion. Each warranty must be signed by an authorized representative of the issuing company.

PART 2 – MATERIALS

2.1 MATERIALS:

- A. General: The products herein specified are totally pre-engineered products of the listed manufacturer and establish criteria for the approval of substitutions. Products must be part of a pre-engineered, reinforced liquid-applied roofing system, equivalent in function, quality, composition and method of application to be considered for approval as an "Approved Substitute".
- B. Roofing System: Cold fluid-applied reinforced polymethyl methacrylate waterproofing membrane. Provide products manufactured and supplied by the following:

1. Kemper System's "Kemperol AC" is a two-component, rapid curing PMMA-based waterproofing system.
 2. Soprema "Alsan RS" PMMA Liquid Applied Solutions, 310 Quadral Drive, Wadsworth, OH 44281; Tel: 800-356-3521; Tel: 330-334-0066; Website: www.soprema.us.
 3. Approved equal
- C. Membrane Flashings: A composite of the same resin material as field membrane with fleece reinforcement; colored aggregate topcoat surfacing or aliphatic polyester polyurethane coating to match field membrane.
- D. Accessories:
1. PMMA Primer: Polymehtyl methacrylate resin for use in improving adhesion of membrane to wood, metal, and cementitious/masonry substrate surfaces, as provided by the following manufacturer:
 - a. Kemper System's Kempertec AC primer.
 - b. Soprema Alsan RS 276 Primer
 - c. Approved equal
 2. PMMA Field Membrane: High performance, rapid-setting polymethyl methacrylate liquid resin, as provided by the following manufacturers:
 - a. Kemper System's Kemperol Membrane.
 - b. Soprema Alsan RS 230 Field
 - c. Approved equal
 3. PMMA Reinforcing Fabric: Non-woven polyester reinforcement, 30 mil thickness.
 - a. Kemper System's Kemperol Fleece.
 - b. Soprema Alsan RS Fleece
 - c. Approved equal
 4. Anti-Skid Aggregate Surfacing Finish Coating Resin: Two-component polymethyl methacrylate-based coating suitable for use to both bond and seal aggregate, as provided by the following Manufacturer:
 - a. Kemper System, Inc.'s Kemperdur AC Finish.
 - b. Soprema Alsan RS 289 Textured Base and Alsan RS Color Additive
 - c. Approved equal
 5. Tools, Accessories, and Cleaners: Supplied and/or approved by roofing system manufacturer for product installation.
 6. Topcoat Surfacing Aggregate: Kiln-dried Surfacing Silica Sand shall be washed, kiln-dried, and dust-free with a size specification of 16 Grit for the entire surface.

7. Leveling and Patching Aggregate: Silica sand shall be washed, kiln-dried, and dust-free, suitable for troweling or pourable self-leveling, round grain or angular with the following size specification:
 - a. For voids less than ¼" in depth: 20 Grit
 - b. For voids ¼" to 2" in depth: 20 Grit
 - c. Mixing Proportions shall be a ratio of resin to sand at 1:2 by volume for leveling, 1:4 by volume for patching, volume or as approved by roofing system manufacturer.
8. Backer Rod: Expanded, closed-cell polyethylene foam designed for use with cold-applied joint sealant.
9. Miscellaneous Fasteners: Appropriate for purpose intended and approved by roofing system manufacturer; length required for thickness of material; as supplied by roofing system manufacturer.
10. Caulking: Single component, non-sag elastomeric polyurethane sealant, as recommended or supplied by roofing system manufacturer for use in making airtight and watertight seals where required.
11. Temporary and Night Sealant: As recommended or required by roofing system manufacturer.

PART 3 – EXECUTION

3.1 ROOFING SYSTEM INSTALLATION

A. Examination:

1. Verify that surfaces and site conditions are ready to receive work.
2. Verify deck/substrate openings, curbs, and protrusions through deck/substrate, and reglets are in place and solidly set.
3. Verify deck/substrate is structurally supported, secure and sound.

B. Preparation of Substrate:

1. General: Surfaces to be prepared as a substrate for the new waterproofing system as follows:
 - a. The contractor shall determine the condition of the existing structural deck/substrate. All defects in the deck or substrate shall be corrected before new waterproofing work commences. Areas of deteriorated deck/substrate, porous or other affected materials must be removed and replaced with new to match existing.
 - b. Existing slab joints shall be prepared and covered as recommended by manufacturer prior to installation of roofing system.

- c. Prepare flashing substrates as required for application of roofing system flashings.
- d. Inspect substrates, and correct defects before application of roofing system. Fill all surface voids greater than 1/8 inch wide with an acceptable fill material.
- e. Remove all ponded water, from the work substrate prior to installing roofing system materials.
- f. The final substrate for roofing system shall be clean, dry, free of loose, spalled or weak material including coatings, mineral aggregate, and flood coat/gravel surfacing, oil, grease, contaminants, abrupt changes in level, waterproofing agents, curing compounds, and free of projections which could damage membrane materials.

2. Concrete:

- a. Concrete shall be free of oil, grease, curing compounds, loose particles, moss, algae growth, laitance, friable matter, dirt, bituminous products and previous waterproofing materials.
- b. Concrete shall be dry with a maximum moisture content of five (5) percent. Determinations of moisture content shall be performed by the Contractor. Contractor shall be responsible to perform periodic evaluations of moisture content during the work. Moisture evaluation results shall be submitted in writing to the Manager and the roofing system manufacturer representative.
- c. Where required, concrete shall be abrasively cleaned in accordance with ASTM D4259 to provide a sound substrate free from laitance with an open concrete surface. When using mechanical methods to remove existing waterproofing products or surface deterioration, the surface profile is not to exceed 1/8 inch (peak to valley).
- d. The substrate shall be sound and all spalls, voids and blow holes on vertical or horizontal surfaces must be repaired prior to placement of the primer coat. Spalls and other deterioration shall be repaired in accordance with the requirements of Section 31.1.O Concrete Repair of the Special Provisions.
- e. Areas of minor surface deterioration of 0.50-inch or greater in depth shall be repaired in accordance with the requirements of Section 31.1.O Concrete Repair to prevent possible ponding of the system, leading to excessive usage of primer and resin.

- f. Extent and location of thin surface patching shall require approval of the Manager and roofing system manufacturer representative prior to the application of any system component.
- 3. Steel/Metal:
 - a. Clean and prepare metal surfaces to near white metal in accordance with SSPC - SP3 (power tool clean) or as required by roofing system manufacturer. Extend preparation a minimum of three (3) inches beyond the termination of the membrane flashing materials. Notch steel surfaces to provide a rust-stop.
 - b. Stainless steel (series 400, 300) shall be abraded to provide a rough open surface.
- 4. Other Surfaces: Remove all contaminants as required by roofing system manufacturer. Surface preparation shall be performed by means approved by Manager.
- 5. Finish Leveling, Patching and Crack Preparation:
 - a. General: polymethyl methacrylate primer/sand mix is the preferred material for all substrate finish leveling, crack and wall/deck preparation and patching. Resin/sand patching mix provides a fast-set time of approximately 12 hours and does not require surface grinding.
 - b. Substrate Leveling & Patching: Substrate conditions are to be evaluated by the Contractor, Manager, and roofing system manufacturer. Perform leveling and patching operations as follows:
 - a) Level uneven surfaces with a leveling mixture of unsaturated polyester resin/primer and approved kiln-dried silica sand in a 1:2 primer to sand ratio by volume. Spread and plane this compound with a squeegee and trowel to achieve a flat surface.
 - b) Fill cavities with a patching mixture of primer and approved kiln-dried sand in a 1:4 primer to sand ratio by volume.
 - c) Silica sand must be kept absolutely dry during storage and handling.
 - d) Any surface to be leveled or filled must first be primed with an appropriate primer.
 - c. Joint and Crack Preparation: Joints, cracks and fractures in the structural deck/substrate shall be prepared as defined below prior to installation of the Roofing system.

- a) Non-Moving Cracks: Determine that crack is non-moving. Clean out crack by brushing and oil-free compressed air. Fill crack with polyurethane sealant. Allow for a minimum of twelve (12) hours cure or as required by sealant Manufacturer.
- b) Moving Cracks: Determine that crack is moving. Clean out crack by brushing and oil-free compressed air. Fill crack with polyurethane sealant. Allow for a minimum of twelve (12) hours cure or as required by sealant Manufacturer. Following full cure of primer, apply resin and 4 inch wide strip of membrane (resin and fleece) in strict accordance with roofing system manufacturer's written instructions.

C. Primer Application:

1. General:

- a. Mix and apply two-component primer in strict accordance with written instructions of roofing system manufacturer. Use only proprietary materials, as supplied by the roofing system manufacturer.
- b. The substrate surface must be dry, with any remaining dust or loose particles removed using clean, dry, oil-free compressed air, industrial vacuum, cloth wipe or a combination of methods.
- c. Do not install primer on any substrate containing newly applied and/or active asphalt, coal-tar pitch, creosote or penta-based materials unless approved in writing by roofing system manufacturer. Some substrates may require additional preparation before applying primer.

D. Roofing System Application:

1. General:

- a. It is recommended to apply the waterproofing membrane immediately following full curing of the primer in order to obtain the best bond between primer and membrane.
- b. Mix and apply cold fluid-applied reinforced polymethyl methacrylate waterproofing membrane in strict accordance with written instructions of Membrane Manufacturer. Use only proprietary membrane resins and materials, as supplied by the membrane manufacturer.
- c. The primed substrate surface shall be dry, with any remaining dust or loose particles removed using clean, dry, oil-free compressed air, industrial vacuum, cloth-wipe or a combination.

- d. Protect all areas where membrane has been installed. Do not work off installed membrane during application of remaining work before twenty-four (24) hours of curing. Movement of materials and equipment across installed membrane is not acceptable. If movement is necessary, provide complete protection of affected areas.
- e. Closely follow the Membrane Manufacturer's recommendation for hot and cold weather application. Monitor surface and ambient temperatures, including the effects of wind chill.

E. Flashing Application:

1. General:

- a. Install flashing system in accordance with the requirements/recommendations of the roofing system manufacturer and as depicted on standard drawings and details. Provide system with base flashing, edge flashing, penetration flashing, counter flashing, and all other flashings required for a complete watertight system. Wherever possible, install the flashings before installing the field membrane to minimize foot traffic over newly installed field membrane.
- b. All membrane flashings shall be installed concurrently with the roofing system as the job progresses. Temporary flashings are not allowed without prior written approval from the roofing system manufacturer. Should any water penetrate the roofing system membrane because of incomplete flashings, the affected area shall be removed and replaced at the Contractor's expense.
- c. Provide a minimum vertical height of 8" for all flashing terminations, unless specifically detailed otherwise. Flashing height shall be at least as high as the potential water level that could be reached as a result of a deluging rain and/or poor slope. Do not flash over existing through-wall flashings or weep holes.
- d. All flashings shall be terminated as required by the roofing system manufacturer.

2. Membrane Flashing – General:

- a. Membrane flashings shall be fabricated with primer appropriate for the substrate surface, resin of the same base chemical type as the field membrane, and fleece of the same weight as the field membrane unless specified otherwise.

- b. Primer, resin, and fleece mixing and application methods as specified for field membranes are also suitable for membrane flashing.
 - c. Fleece shall overlap 2 inches minimum for all joints. Fleece shall be cut neatly to fit all flashing conditions without a buildup of multiple fleece layers. Work wet membrane with a brush or roller to eliminate blisters, openings, or lifting at corners, junctions, and transitions.
3. Pipes, Conduits, and Unusually Shaped Penetrations:
- a. Flash all penetrations using cold liquid-applied reinforced unsaturated polyester roof membrane with approved broadcast mineral aggregate surfacing or aliphatic polyester polyurethane coating. Flashing material shall be the same resin used in the field membrane with 165 fleece reinforcement.
 - b. Flashing is typically constructed as a two-part assembly consisting of a vertical wrap and a horizontal target patch. There must be a minimum of a two (2) inch overlap between vertical and horizontal flashing components.
4. Curb and Base Flashings:
- a. Wall, curb and base flashings shall be installed to solid substrate surfaces only. Adhering to gypsum-based panels, cementitious stucco, synthetic stucco, wood or metal siding, and other similar materials is not acceptable.
 - b. Reinforce all transition locations and other potential wear areas with a four (4) inch wide membrane strip evenly positioned over the transition prior to installing the exposed flashing layer.
 - c. Reinforce all inside and outside corners with a four (4) inch diameter conical piece of membrane prior to installing the exposed flashing layer.
 - d. All pins, dowels and other fixation elements shall be flashed separately with a vertical flashing component prior to installing the exposed flashing layer.
 - e. Extend flashing a minimum of four (4) inches onto the field substrate surface.

F. Surfacing and Finishes:

1. Provide and install approved kiln-dried mineral surfacing with dry roller to achieve non-skid surface. Note: surfacing is considered a non-warranty maintenance item, and will require re-application periodically.
 2. Broadcast specified and approved sand or aggregate in excess into a bonding coat application of Membrane Manufacturer's approved methyl methacrylate-based aggregate coating system applied over clean, cured membrane at the manufacturer's recommended application rate.
 3. Aggregate shall be applied to excess to obtain uniform and full coverage.
 4. Following minimum 2 hour cure time remove loose/un-embedded mineral aggregate by blowing with oil-free compressed air or with a vacuum. Re-broadcast clean mineral aggregate as required to provide full embedment and coverage of membrane.
 5. Seal aggregate surface with a sealing coat application of Membrane Manufacturer's approved aggregate coating, applied at the manufacturer's recommended application rate. After completion of surfacing, avoid any traffic for a minimum of three (3) hours to allow for surfacing to cure.
- G. Temporary Closures & Waterstops: Contractor shall be responsible to ensure that moisture does not damage any completed section of the new waterproofing system. Completion of flashings, terminations, and temporary closures shall be completed as required to provide a watertight condition. All temporary closures shall be made as recommended or required by the roofing system manufacturer.
- H. Protection: Upon completion of roofing and flashings (including all associated work), institute appropriate procedures for surveillance and protection of roofing during remainder of construction period. Protect all areas where roofing has been installed.
- I. Closeout:
1. Correction of Work: Work that does not conform to specified requirements including tolerances, slopes, and finishes shall be corrected and/or replaced. Any deficiencies of roofing system application, termination and/or protection as noted during the roofing system manufacturer's inspections shall be corrected and/or replaced at Contractor's expense.
 2. Clean-Up: Site clean-up, including both interior and exterior building areas that have been affected by construction, shall be restored to pre-construction condition.

PART 4 – PAYMENT

Payment will not be made directly but shall be included in the Lump Sum Bid of which it is a part. Such payment shall represent full compensation for furnishing all materials, labor, tools, equipment and incidentals required to complete the work.

END OF SECTION

SECTION 08900 – LOUVERS AND VENTS

PART 1 – GENERAL

1.1 DESCRIPTION:

- A. Furnishing of all labor, materials, tools and equipment necessary for providing and installing stainless steel fixed weather louvers designed to protect air intake and exhaust openings, with anchors, brackets and attachments into reservoir wall openings work covered in this section and the Project Drawings.

1.2 SUBMITTALS:

- A. Product Data: Include manufacturer's product specifications, technical support data, installation and maintenance recommendations and standard details for each type of louver required, including flashing methods, hardware and accessories.
- B. Certification: Provide certification by a recognized, independent testing laboratory certifying that each required type of louver complies with performance requirements indicated.

1.3 PERFORMANCE REQUIREMENTS:

- A. The beginning point of water penetration, based on AMCA Water Penetration Test criteria, shall be a minimum of 1000 fpm free area velocity.
- B. Individual louver panels shall be designed to withstand the wind loading per the Building Code of Hawaii County, International Building Code, amended 2006 edition or 25 pounds per square foot, whichever is greater.

1.4 DELIVERY, STORAGE, AND HANDLING:

- A. Delivery: Deliver materials to Project site in manufacturer's original, sealed and labeled packaging with manufacturer's name, product brand name and type, date of manufacture, and directions for storing.
- B. Storage: Store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions for protection of units.
- C. Handle all materials in such a manner as to preclude damage to finish or unit.

1.5 PROJECT CONDITIONS:

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by the manufacturer.
- B. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

1.6 WARRANTY:

- A. Manufacturer shall provide a standard warranty for louver systems for a period of 1 year from date of installation, no more than 18 months after shipment from manufacturing plant. The louver coating system shall have a 5-year minimum warranty for defects or premature wear. When notified in writing from DWS of a manufacturing defect, manufacturer shall promptly correct deficiencies without cost to DWS.
- B. Warranty includes coverage of materials and labor in full by the manufacturer.

PART 2 – MATERIALS

2.1 FABRICATED FIXED LOUVER:

- A. Description and Features: The 4-inch wide, stainless steel, type 316 fixed weather louvers shall be designed to protect air intake and exhaust openings in building exterior walls with drain gutters in the head member and horizontal blades, channeling water to the jambs where water travels down a vertical downspout and out at the sloped sill. The louver construction shall utilize mechanical fasteners.
- B. Extrusion frame members are to be 20-gauge stainless steel.
- C. Louver blades are to be 20-gauge stainless steel, drainable blades fixed at 45-degree angle.
- D. Manufacturers: Examples of manufacturers meeting the above requirements:
 - 1. NCA Manufacturing, Inc. – Model “SLD-4-45-GL” (www.ncamfg.com), Clearwater, FL (727) 441-2651
 - 2. Approved equal
- E. Bird Screen: Provide factory-provided bird screens for each louver opening, ½” x ½” x 19-gauge stainless steel with a removable frame on the interior of the louver.

- F. Insect Screen: Provide aluminum mesh or fiberglass mesh insect screens for each louvered opening. Locate bug screens on inside (toward reservoir interior) of required bird screens. Design louver and hardware to accommodate screens in a tight-fitting removable arrangement with a minimum of exposed fasteners and latches.
- G. Fasteners: Provide stainless steel, epoxy adhesive, or other materials warranted by the manufacturer to be non-corrosive and compatible with trim, hardware, anchors and other components of louver unit. Where fasteners screw-anchor into frame members less than 0.125 inches thick, reinforce the interior to receive screw threads, or provide standard, non-corrosive, pressed-in, splined grommet nuts.
- H. Anchors, Clips and Louver Accessories: Fabricate anchors, clips and louver accessories of non-magnetic stainless steel. Anchors, clips and louver accessories fabricated of hot-dip zinc coated steel or iron may be used for concealed work.

2.2 FABRICATION REQUIREMENTS:

- A. Fabricate to minimize field adjustments, splicing, mechanical joints and field assembly nuts.
- B. Preassemble units to greatest extent possible and disassemble as necessary for shipping and handling.
- C. Clearly mark units for reassembly and coordinated installation.
- D. Join frame-to-frame connections by welding in shop, and frame and lade members to one another by riveting, except where field bolted/screwed connections between frame members are necessary due to size of louver.
- E. Maintain equal blade spacing to produce uniform appearance.

PART 3 – EXECUTION

3.1 LOUVER INSTALLATION:

- A. Verify opening in metal frame preparation is within installation tolerances and proceed only after unsatisfactory conditions have been corrected.
- B. Install louver in accordance with manufacturer's instructions, resulting in a plumb, level, in-plane of wall and aligned with adjacent work installation.

C. Install continuous exterior grade elastomeric joint sealant at louver-frame opening joint on full perimeter.

D. Clean louver surface in accordance with manufacturer's instructions.

PART 4 – PAYMENT

No separate payment for will be made; compensation for such work shall be deemed to be included in the Lump Sum Bid for the item of which it is a part.

END OF SECTION

SECTION 09900 – RESERVOIR PAINTING

PART 1 – GENERAL

1.1 DESCRIPTION:

- A. This item of work shall include the furnishing of labor, materials, tools, and equipment necessary for completing exterior painting of surfaces in accordance with Section 303.27 of the Water System Standards, dated 2002, and as supplemented hereinafter, and applicable to this project. Items to be painted shall include all new work with a painted surface and as indicated.
- B. Work on Other Sections: Shop coats on ferrous metals.
- C. No paint finish is required on the following: Nonferrous metals, fiber reinforced plastic, plastic lumber, unless specifically noted on Drawings.
- D. Packages and Labels: Deliver materials in original containers, manufacturer's labels thereon. Do not open container or remove labels until Manager has approved material.
- E. Storage: Store paint materials out of direct sunlight and as recommended by the manufacturer. Do not store containers exposed to weather. Storage place shall be a location agreed upon by the Contractor and Manager.
- F. Fire Protection: Contractor shall exercise extraordinary care to prevent fire. Keep rubbing cloths and oily rags in tightly closed metal containers.
- G. Protection and Cleaning: Protect adjacent work with drop cloths. Clean paint splatters and stains from completed surfaces.
- H. Begin painting only after paint manufacturer's representative has approved the surface for painting. The work shall be performed in strict conformance with the paint manufacturer's direction.

1.2 SUBMITTALS:

- A. Submit six (6) copies of the following to the Department of Water Supply for approval. No materials shall be ordered prior to the DWS's approval..
 - 1. Submit complete and detailed list of materials proposed for use, their MSDS sheets and certification the proposed products meet the project requirements.
 - 2. Letter from paint manufacturer, stating that proposed materials are the best of their respective kinds and suitable for the intended purpose and project conditions.

3. Samples: Submit six (6) sets of color samples approximately 8 ½" x 11" in size for each proposed color and texture for approval by the Manager before proceeding with the work and make as many samples as required to secure desired results.

1.3 QUALITY ASSURANCE:

- A. The Painting Contractor must be capable of performing the various items of work as specified. If required by the Manager, the Painting Contractor shall furnish a statement covering experience on similar work, a list of machinery, plan and other equipment available for the proposed work, and a financial statement, including a complete statement of the Paint Contractor's financial ability and experience in performing similar painting and coating work. The Painting Contractor shall have a minimum of five (5) years practical experience and a successful history in the application of the specified products to concrete surfaces. Upon request, the Painting Contractor shall substantiate this requirement by furnishing a list of references, which shall include jobs of similar nature.
- B. The painting contractor shall coordinate the presence of the manufacturer's representative and shall provide the manufacturer's representative with a schedule of his work. The schedule shall be designed in such a way as to meet project requirements.
- C. Paint manufacturer's representative is required to be on-site as often as the representative deems necessary to assure the painted surfaces and the painting are in accordance with the manufacturer's directions and in no way negate the manufacturer's warranty.
- D. Paint shall not contain any materials determined hazardous, such as lead.

1.4 PROJECT CONDITIONS:

- A. Contractor is responsible for defective work from any cause, including unsuitable and improperly prepared surface, or presence of vapor drive not properly addressed. Prime all surfaces as required by finish coat manufacturer.
- B. Protection: Before applying paint, remove or provide ample protection for hardware, plates, light fixtures, and similar items. Replace upon completion. Employ skilled craftsmen for removing and reinstalling above items. Protect surfaces not to be painted and remove any unintended paint immediately.
- C. Application of the first coat of paint constitutes the Contractor's acceptance of the surfaces and the responsibility for it, including the removal of hazardous materials.

PART 2 – MATERIALS

2.1 MATERIALS:

- A. Material List: Submit complete and detailed list of materials proposed for use on the work. Include letter from manufacturer, stating that materials are the best of their respective kinds and suitable for the intended purpose.
- B. Paint Schedule: Schedule for the various substrates shall be in accordance with Division 400, Section 402 – Approved Material List of the Water System Standards, dated 2002, and approved amendments.
- C. Colors shall be as selected by the Department of Water Supply for the following items with paint finishes:
 - 1. Exposed pipe (except copper), fittings, valves and equipment.
 - 2. Electrical work and conduits.
 - 3. Potable water piping and components.
 - 4. Access and observation hatch cover, frames (both interior and exterior surfaces).
 - 5. Exterior ladder and cage, and their supports.
- E. The finish coat for exterior of reservoir shall be #873 Alligator Pear, ICI Paints, Leaf #96 or approved equal color scheme. The first coat of finish paint shall be a different shade from the final finish coat providing visual assurance all surfaces has two coats of the finish paint.
- F. The following surfaces shall not be painted and shall be protected during the surface preparation and painting of adjacent areas:
 - 1. Stainless Steel
 - 2. Metal Letters
 - 3. Nameplates
 - 4. Grease Fittings
 - 5. Brass and Copper
 - 6. Buried Pipe, unless specifically required in the piping specifications

PART 3 – EXECUTION

3.1 SURFACE PREPARATION:

- A. All surfaces must conform to manufacturer's recommendations and to the satisfaction of the Manager. All surfaces of different material are to be considered separately and each are to be treated as separate cases prepared as recommended by the manufacturer.
- B. All metal surfaces to be painted shall be dry, clean and free from dirt, oil, grease, rust, scale or other foreign matters.
- C. Concrete surfaces shall be at least one month old, dry, clean, and free of dust, plaster, oils, grease, waxes, curing compounds, and other foreign matter.

3.2 MIXING AND THINNING:

- A. Proprietary products will not negate any warranty of the paint. Mix and thin in strict accordance with manufacturer's printed directions under direction of manufacturer's representative.
- B. Other Materials: Mix and thin in accordance with standard practice and only as approved by the paint manufacturer.

3.3 APPLICATION:

- A. Workmanship: Highest quality, by skilled workers, in accordance with best trade practices. Spread material evenly, without runs or sags. Cut sharp lines against other materials. Vary shades of successive coats to prevent skipping. Prime backs of frames and trim with sealer or paint. Allow ample time between coats for thorough drying. Rate of primer and paint application shall be in strict conformance with manufacturer's direction.
- B. Defective Work: Contractor is responsible whatever the cause; refinishing work will be at no additional cost to the owner. Repair work that is damaged during construction. Leave painted surfaces in first class condition at time of final acceptance.
- C. Painting shall be at rates of application per layer in strict accordance with the manufacturer's direction to achieve the total dry film thickness specified.
- D. Application of paint system components shall be by brush or rollers only, unless otherwise approved by Manager.

3.4 CLEAN-UP:

- A. Clean all misplaced paint and remove all excess paint, materials and equipment from the job site upon completion.
- B. Leave premises neat and clean in a manner acceptable to the Manager.

PART 4 – PAYMENT

Payment will not be made directly but shall be included in the Lump Sum Bid of which it is a part. Such payment shall represent full compensation for furnishing all materials, labor, tools, equipment and incidentals required to complete the work.

END OF SECTION

SECTION 13600 – RESERVOIR EXPANSION AND CONSTRUCTION JOINTS

PART 1 – GENERAL

1.1 DESCRIPTION:

- A. Furnish of all labor, materials, tools and equipment necessary to complete the reservoir expansion and construction joints installation.

1.2 SUBMITTALS:

- A. Furnish certification from manufacturers stating the submitted material meets all the requirements specified herein. The Manager, at his option, may take samples of any materials and have them tested by an independent testing laboratory to verify their compliance with these Specifications. All such costs shall be borne by the Department of Water Supply. If any materials should fail to meet these Specifications, all costs for further testing of the replacement material shall be borne by the Contractor.

PART 2 – MATERIALS

2.1 WATERSTOPS:

- A. Waterstops shall meet the requirements of Water Systems Standards, Section 212.09, with the following revisions and additions and the size and profile specified on the Drawings.
- B. Materials:
 - 1. Thermoplastic Vulcanizate (TPV)
 - 2. Virgin Polyvinyl Chloride (PVC)
 - 3. No reclaimed PVC shall be used in the compound.
- C. The finished waterstop material shall meet the following minimum requirements:
 - 1. Tensile strength: 2,000 psi (ASTM D 412)
 - 2. Ultimate elongation: 350% (ASTM D 412)
 - 3. Shore hardness: 75 min. (ASTM D 2240)
 - 4. Specific gravity: 0.95 min. (ASTM D 792)
 - 5. Stiffness in flexure: 600 psi (ASTM D 747)
 - 6. Cold brittleness point: 35°F max. (ASTM D 746)
 - 7. Water absorption (48 hrs.): 0.320% max. (ASTM D 570)
 - 8. Tear resistance: 275 lb./in. (ASTM D 624)

- D. VINYLEX, 3400 Tree Court Industrial Blvd., St. Louis, MO 63122 (Phone 800-325-3602) and GREENSTREAK PLASTIC PRODUCTS, Box 7139, St. Louis, MO 63177 (phone 314-225-9400) are two of several suppliers who can furnish waterstops meeting these requirements. Approved equal materials may also be used.
- E. Waterstop intersection joints shall be prefabricated with a 12-inch minimum length from the joint.

2.2 JOINT SEALERS:

- A. Joints, not requiring waterstops or when so indicated on the Drawings, shall be sealed with a mastic joint sealer material of uniform, stiff consistency that does not contain solvents.
- B. The mastic shall tenaciously adhere to primed concrete surfaces, shall remain permanently mastic and shall not contaminate potable water.
- C. The material shall be of a type that will effectively and permanently seal joints subject to movements in concrete.
- D. The mastic joint sealer shall be an acceptable two part, self-leveling (or gun grade), non-staining, polyurethane elastomeric sealant that cures at ambient temperature. Acceptable sealants shall conform to ASTM C 920 or Federal Specification TT S 00227E.
- E. For sloping joints, vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used; all such compounds shall conform to the requirements of ANSI/ASTM C 920 Class 12-1/2, or Federal Specification TT-S-0027 E (3), Type II.
- F. For plane horizontal joints, the self-leveling compounds which meet the requirements of ANSI/ASTM C 920 Class 25, or Federal Specification TT-S-0027 E (3), Type I shall be used. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics, and having a Shore "A" hardness range of 25 to 35, shall be used.
- G. Primer materials, if recommended by the sealant manufacturer, shall conform to the printed recommendations of the sealant manufacturer.
- H. Acceptable polyurethane materials are PSI-270 RESERVOIR SEALANT, as manufactured by POLYMERIC SYSTEMS, INC., Phoenixville, PA (610-935-1170), SIKAFLEX/2C POLYURETHANE ELASTOMERIC SEALANT, as manufactured by SIKA CHEMICAL CORP., Santa Fe Springs, CA (310-941-0231) and SELECT SEAL U-227 RESERVOIR GRADE, as manufactured by SELECT PRODUCTS CORP., Costa Mesa, CA (714-429-0808), or approved equal.

2.3 PREFORMED JOINT FILLER:

- A. Preformed joint filler material shall be of the preformed non-extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane of firm texture. Bituminous fiber type will not be permitted. All non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 for Type I, except as otherwise specified herein.

2.4 BACKING ROD:

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

2.5 BOND BREAKER:

- A. Bond breaker shall be SUPER BOND BREAKER WATER BASE as manufactured by Burke Company, San Mateo, California; SELECT EMULSION CURE 309, as distributed by Select Products Co., Costa Mesa, CA (clear or white pigmented) or equivalent. Fugitive dye may be used in bondbreakers if recommended by manufacturer.

PART 3 – EXECUTION

3.1 WATERSTOP INSTALLATION:

- A. The waterstop shall be correctly positioned in the forms with the center of the waterstop centered on the joint.
- B. In cases where preformed expansion joint material is used in conjunction with the waterstop, allowance shall be made for equal waterstop embedment on each side in the concrete.
- C. Waterstop shall be held in place in the forms by use of a split form or other approved method that will positively hold the waterstop in the correct position and to the correct alignment.
- D. All waterstop intersection joints shall be welding in the shop and shipped to the project site.
- E. Field Joints
 - 1. Field joints shall be restricted to properly aligned, straight butt joints only.

2. Use only recommended splicing tool for field joints of waterstop.
 3. Centerbulbs shall be compressed or closed when welding to non-centerbulb type or edge.
- F. Horizontal waterstops shall be bent up during placing of concrete until the concrete has been brought to the level of the waterstop; additional concrete shall then be placed over the waterstop, after which the concrete shall be thoroughly vibrated.
 - G. All horizontal and vertical waterstops, which are not accessible during pouring, shall be tied off in two directions every 12 inches to prevent bending over during concrete placement or consolidation.
 - H. A hog ring or nail may be driven through both ends of the waterstop to facilitate placing and tying of waterstops to reinforcing steel forms or form ties.
 - I. All waterstops shall be properly spliced and joints shall be checked for strength and pinholes after splicing.
 - J. Splices shall be strong enough to develop a pulling force of 75 percent of the waterstop strength and shall be watertight.
 - K. Ends of the radial waterstop in the floor slab joints shall be connected to the circumferential waterstop in the floor to wall footing joint.

3.2 INSTALLATION OF JOINT SEALER:

- A. Joint sealed areas shall be sandblasted or roughened and blown clean of dust and sand with compressed air before the material may be applied.
- B. Joints shall be primed (if required) prior to installing the joint sealer, install bond breaker tape to bottom of joint. Sealant shall be applied in accordance with the manufacturer's recommendations.

PART 4 – PAYMENT

Payment will not be made directly but shall be included in the Lump Sum Bid of which it is a part. Such payment shall represent full compensation for furnishing all materials, labor, tools, equipment and incidentals required to complete the work.

END OF SECTION

SECTION 13700 – RESERVOIR WALL, BASE, AND TOP JOINTS

PART 1 – GENERAL

1.1 DESCRIPTION:

- A. Furnish of all labor, materials, tools and equipment necessary to complete the reservoir wall, base, and top joints

1.2 SUBMITTALS:

- A. The Contractor shall provide the Manager a 2-foot minimum length of each of the closed cell neoprene pads and the neoprene bearing pads in order to test the pads for compliance with these Specifications.
- B. Furnish certified mill certificates showing that the material meets all of the requirements specified here in. The Manager, at DWS option, may take samples of any materials and have them tested by an independent testing laboratory to verify their compliance with these Specifications. All such costs shall be borne by the DWS. If any materials should fail to meet these Specifications, all costs for further testing of the replacement material shall be borne by the Contractor.
- C. For manufactured items submit product data sheets indicating the properties of the proposed item meet the requirements of these specifications.

PART 2 - MATERIALS

2.1 WATERSTOPS:

- A. Waterstops shall conform to requirements in Section 13600 - RESERVOIR EXPANSION AND CONSTRUCTION JOINTS. The size and location of the waterstop shall be as shown on the Drawings.

2.2 NEOPRENE BEARING PADS:

- A. Neoprene pads shall be of dimensions and hardness shown on the Drawings and shall be made by an approved manufacturer.
- B. The material for 40 durometer neoprene pads shall conform to ASTM D-2000 M2BC414A14C12F17 and the material for 30 durometer neoprene pads shall conform to ASTM D-2000 M2BC310A14C12F17.
- C. Unless otherwise specified on the Drawings, neoprene pads shall be of 40 durometers.
- D. DACOM INDUSTRIES CO., 10661 N. Lombard, Portland, OR 97203 (Phone

503-978-0801 and WEST AMERICAN RUBBER COMPANY, INC. (Phone: 714-532-3355) or approved equal, are two of several suppliers who can furnish neoprene pads meeting these requirements.

2.3 CLOSED CELL NEOPRENE FILLER PADS:

- A. Closed cell neoprene pads shall be used as a filler material in the flexible joints between the wall and wall footing and between the wall and roof connection in the areas not taken up by the solid neoprene bearing pads and waterstops.
- B. The materials shall be medium grade closed cell neoprene conforming to 2C3 of ASTM D 1056-00 or 2A3 based on ASTM D 1056-85 and as further specified here-in and on the Drawings.
 - 1. Compression deflection: 9-13 PSI
 - 2. Density: 18-28 PCF
 - 3. Water absorption by weight: 0.5 lbs/ft²
 - 4. Temperature range:
 - Low (flex without cracking): -30°F
 - High continuous: 150°F
 - High intermittent: 200°F
 - 5. Heat aging (7 days @ 158°F): 5% max. (7 days at 158°F)
 - 6. Tensile strength: 100 PSI min.
 - 7. Elongation: 170% min.
 - 8. Resilience: 20%-40% (bayshore % rebound average 1/2" thickness @ 72°F)
- C. HANNA RUBBER CO. "R-431-N", or CYPRESS SPONGE 431N or 423N, or approved equal, are acceptable materials.

2.4 SOFT MASTIC:

- A. Self-leveling soft mastic shall be installed in all voids and cavities around bearing pads, waterstops and seismic cable sleeves. Such material shall be installed with a consistency that will not adversely affect the quality of rubber or neoprene materials.
- B. SIKAFLEX 1A, as manufactured by Sika Corporation or SELECT SEAL U-230, as manufactured by Select Products Company, or approved equal, are acceptable materials.

PART 3 – EXECUTION

3.1 WATERSTOP INSTALLATION:

- A. Waterstops shall be continuous and shall be installed where shown. The method of installation shall be as specified in Section 13600 – RESERVOIR EXPANSION AND CONSTRUCTION JOINTS.

3.2 BEARING AND NEOPRENE FILLER PADS:

- A. Bearing and filler pads shall be installed as indicated on the Drawings.
- B. Bearing and filler pads shall be glued to the concrete with an approved rubber cement material to prevent uplift of the pads during placement of concrete.
- C. In addition, all pads shall be held down with approved plastic shim plates or 'adobes' placed under the reinforcing steel as shown.
- D. Nailing down pads will not be permitted.
- E. All voids and cavities between bearing and filler pads, waterstop and seismic cable sleeves, irrespective of whether these voids are large or small, shall be filled with a soft mastic.
- F. Closed cell neoprene shall be ordered at least 1/4 inch wider than theoretically required to facilitate placing and to reduce development of voids between filler pads, bearing pads and waterstops.
- G. Contractor's workmanship shall be such that no cement grout or concrete seepage will occur through the bearing and filler pad area resulting in a restraint of radial wall movements.
- H. Neoprene bearing pads and one or more closed cell neoprene pads are required between the top of the wall and the underside of the roof. Secure pads as described above in item #2. Trim closed cell neoprene pads as required to fit around seismic tubes at top of wall. Any void areas between such pads shall be filled with soft mastic to prevent any mortar from the roof pour to come into contact with the wall top.

PART 4 – PAYMENT

Payment will not be made directly but shall be included in the Lump Sum Bid of which it is a part. Such payment shall represent full compensation for furnishing all materials, labor, tools, equipment and incidentals required to complete the work.

END OF SECTION

DIVISION 16 – ELECTRICAL

SECTION 16050 –BASIC MATERIALS AND METHODS

PART 1 – GENERAL

1.1 GENERAL CONDITIONS

The General Provisions and Special Provisions preceding specification shall govern this Section.

1.2 SUMMARY

- A. This section provides the specifications for general electrical work. See other specification sections for more detailed specifications related to specific electrical systems.
- B. Specification and Drawings complement each other and what is specified, scheduled or mentioned by one shall be binding as if called for by both. Specification and Drawings are intended to specify nature, quantity and quality of electrical work.
- C. The Contractor shall furnish all labor, materials, tools, equipment, electricity, fuel, shipping and delivery, and appliances required to provide all Electrical Work, complete, as indicated on the drawings and/or as specified herein. The drawings note various sizes of equipment as determined for basis of design; the electrical work, however, shall be installed to comply with the equipment furnished by the successful supplier and shall be based on the approved shop drawing submittals. The work shall include but not necessarily be limited to, the following:
 - 1. Complete underground service entrance raceways, including all handholes and pullboxes required for electric utility services.
 - 2. Complete Hawaii Electric Light Company utility metering system, including all appurtenances for a complete system.
 - 3. Complete service equipment and grounding system.
 - 4. Complete electrical system for the tank site.
 - 5. Coordination with Hawaii Electric Light Company for power services.
 - 6. Connection and testing of appliances and equipment furnished by others requiring electrical connections.
 - 7. Final adjustment and testing of the complete electrical installation.
 - 8. The Contractor shall make arrangements with the Hawaii Electric Light Company for electrical service to the site, as indicated on plans. The Contractor shall provide service equipment and suitable metering provisions.
 - 9. The Owner shall pay only non-recurring off-site power service charges incurred in providing this service but the Contractor shall pay for services

and all other work pertaining to this contract and shall coordinate the request and installation so service is available when required for testing and completion of the contract.

- D. During bidding and construction, Contractor shall coordinate his work with utilities and other trades to avoid omissions and overlapping responsibilities. Electrical Contractor shall notify other trades and suppliers of project voltages and of existing equipment when new work must be compatible with existing conditions.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. Materials Connected But Furnished & Installed Under Other Sections: This list is for the convenience of the Contractor, and materials connected are not necessarily limited by this list.
1. Level transmitters
 2. Flow transmitters
 3. Pressure transmitters
 4. Meters and final connection of service provided by Hawaii Electric Light Company
 5. Equipment utilizing electricity shall be provided by respective sections of this contract. Installation of equipment complete with power wiring and electric controls and interlock wiring shall be part of Electrical Work.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01300 - SUBMITTALS.
- B. Shop drawings and catalogue cuts for substitute materials shall clearly specify compliance with and/or deviation from specified material. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; and "achieve the same end use and results as materials formulated in accordance with the referenced publications". Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance. Review of shop drawings and catalogue cuts shall not release Contractor from complying with intent of specification and drawings. Partial or incomplete submittals will be returned without review.
- C. Shop Drawings: Submit complete shop drawings and manufacturer's literature for the Engineer's review before any work is ordered or fabricated. All submittals shall bare the approval of the general contractor and the electrical contractor. Partial or incomplete submittals or submittals lacking the general contractor's and electrical contractor's approval will be returned without review. Submit manufacturer's literature for the following:
1. Panelboards
 2. Enclosures and Cabinets
 3. Junction Boxes

4. Receptacles
5. Conduit
6. Wiring
7. Nameplates
8. Light Fixtures

D. As-Built Drawings: Submit as-built drawings as specified under Section 01700 - CONTRACT CLOSEOUT.

1.5 GUARANTEE AND CERTIFICATE

Any item of material, apparatus, equipment furnished and installed, or constructed by the Contractor showing defects in design, construction, quality or workmanship within one year from the date of final acceptance by the Owner shall be replaced by such new material, apparatus or parts as may be found necessary to make such defective portion of the installation conform to the true intent and meaning of the specification and/or the drawings. Such repairs or replacement shall be made by the Contractor, free of all expense to the Owner.

1.6 COORDINATION WITH UTILITY COMPANIES AND OTHER TRADES

During bidding and construction, Contractor shall coordinate his work with utilities, and other trades to avoid omissions and overlapping of responsibilities.

1.7 CODES, REGULATIONS AND STANDARD SPECIFICATIONS

- A. Work shall conform to latest edition of National Electrical Code.
- B. Applicable rules, standards and specifications of following associations shall apply to materials and workmanship:
 - American National Standards Institute (ANSI)
 - American Society for Testing and Materials (ASTM)
 - Institute of Electrical and Electronics Engineers (IEEE)
 - National Electrical Manufacturer's Association (NEMA)
 - National Fire Protection Association (NFPA)
 - Underwriters' Laboratories, Inc. (UL)

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General: All materials shall be new, except as specifically noted, and shall bear the label of Underwriters' Laboratories whenever standards have been established and label service is normally and regularly furnished by the agency.
- B. Conduit:

1. Conduits: EMT and galvanized rigid steel, 3/4" minimum diameter with compression or threaded fittings, respectively. Aluminum conduits shall not be used.
 2. Non-Metallic Conduit: PVC Schedule 40, 3/4" minimum diameter.
 3. Flexible Conduit: 3/4" minimum, zinc-coated inside and outside; for damp, wet, moist, or corrosive areas -- liquid-tight with factory fittings and UV stabilized PVC jacket.
- C. Conductors: Conductors shall be copper, No. 12 AWG minimum; No. 10 AWG and smaller, solid and round; No. 8 AWG and larger, 7 or 19 strands concentric. All conductors No. 6 and smaller shall be types THW for interior use or RHW for exterior use. All conductors No. 4 AWG and larger shall be type THWN-2 for interior use; or RHW-2 or USE-2 for exterior use.
- D. Outlet and Small Junction Boxes: Pressed, zinc-coated steel, minimum nominal size 4", minimum depth 1-1/2", with raised cover- ring for devices in concrete masonry units. Exposed boxes and weather exposed boxes shall be ferrous alloy, prime painted and enamel finished, with threaded hubs for conduit connection. Surface mounted boxes shall be smooth walled with clean 90 degree corners.
- E. Large Junction Boxes: For dry interior locations, the box shall be fabricated from NEC gauge galvanized steel with matching screw-on type cover, field punched knockouts. Flush mounted junction boxes shall have flange type covers. For exterior, damp, wet, or corrosive locations, boxes shall be NEMA 4X stainless steel (316), pad lockable. All screws and hardware shall be stainless steel (316).
- F. Enclosures and Cabinets: Enclosures and cabinets for panelboards, enclosed circuit breakers, and safety disconnect switches shall be NEMA type, fabricated from galvanized steel, or as indicated, prime painted and enamel finished according to NEMA specifications. For dry interior locations, enclosures shall be NEMA 1. For exterior, damp, wet, or corrosive locations, enclosures shall be NEMA 4X stainless steel (316) with stainless steel (316) fasteners and hardware, pad lockable. Provide enclosures made of continuous welds. Enclosures made of bolted panels/parts will not be allowed.
- G. Device and Cover Plates:
1. Device covers outlets in damp, wet, or corrosive locations shall be weatherproof with lockable stainless steel (316) covers. Covers shall permit plugs to be connected without compromising the integrity of the protective nature of the cover while in use.
- H. Convenience Single and Duplex Receptacles:
1. Single and Duplex, 20 ampere, 125-volt, back and side wired, 3 wires, grounding type in ivory plastic body (provide red body for receptacles on emergency circuits), specification grade, with parallel and ground U-shaped slots. Enclose in outlet box and device plate. Hubbell SNAP5262, Leviton No. 5362 or pre-approved equal.

2. Ground Fault Circuit Interrupting (GFCI) receptacles shall be similar to the above except shall have test and reset switches and maximum allowable leakage current shall be 5 milli-amperes. Receptacles in damp and wet locations shall be of the GFCI type.
 3. Receptacles installed in exterior, damp, or wet locations shall be UL Listed weather resistant per NEC 406.9(A).
- I. Panelboard: Flush-mounted or surface-mounted as noted, ratings as indicated, 1-phase, 3WSN, ground bus, copper bussing, circuit breaker complement as shown, complete with lockable door, trim, type written directory, and 2-ply nameplate. Short circuit amperes interrupting capacity withstand ratings as indicated. Series rated panelboards not allowed. Full pole circuit breakers (half pole circuit breakers not allowed). Flush mounted panelboards shall be provided with flange type covers. Lockable with all new locks keyed alike. Eaton, Square D, General Electric, Siemens or pre-approved equal.
 - J. Surge Protective Device (SPD): Provide an SPD in panelboards where indicated on the drawings. Each SPD shall be bus connected for parallel operation, rated for 120/240V, 1-phase, 3-wire systems, and have a minimum surge rating of 50kA per phase. The SPD shall be UL 1449 and UL 1283 Listed (latest editions). Each SPD shall have LED status indicator lights.
 - K. Nameplates: Laminated nameplates shall be provided for each panelboard, junction box, and cabinet for identification purposes. Nameplates shall be laminated plastic shall be 1/8-inch thick Melamine plastic, black with white center core. Letters, numbers, symbols, or pictographs shall be incised a minimum of 1/32-inch into the plastic to expose the white core. Size of nameplate shall be 1-inch by 2-1/2 inches minimum. Lettering shall be minimum 1/4-inch high normal block lettering. Equipment designations shall be as indicated on the Drawings.
 - L. Light Switches: Single or double pole, 3 or 4 way, as required, non-mercury, quiet, 20 amperes, 120-277 volt, UL labeled AC type, silvered contacts, ivory, tumbler switch with endurance of 10,000 make-breaks. Enclose in outlet box and device plate.
 - M. Light Fixtures: Provide light fixtures complete with necessary lamps, ballasts, starters, and accessories, according to the "Light Fixture Schedule".
 1. LED Drivers shall consist of a high frequency inverter, and power control and regulation circuitry. Drivers shall be Class 2 certified and meet safety standard UL 1310.
 - N. Hardware, Supports, Backing, Etc.: All hardware, fasteners, supports, backing and other accessories necessary to install electrical equipment shall be provided. Wood materials shall be "wolmanized" treated against termites, iron or steel materials shall be galvanized for corrosion protection, and non-ferrous materials shall be brass or bronze. Installations in damp, wet, or corrosive locations shall be of stainless steel, 316.

PART 3 - EXECUTION

3.01 GENERAL

- A. Rules and Permit: The entire installation shall be made in strict accordance with the latest rules and regulations of the National Board of Fire Underwriters, the currently adopted edition of the National Electrical Code and the Electrical Branch of the local Building Department. The Contractor shall obtain and pay for the electrical permit as required by local laws and rules. All work shall be inspected by the proper local authorities as it progresses. The Contractor shall pay all inspection fees and shall deliver certificates of completion and inspection to the Engineer before final payment will be made. Costs of permits and inspection fees shall be included in the Contractor's bid price.
- B. Construction Methods: Construction shall conform to construction practices as recommended by the American Electricians Handbook by Croft (latest edition), Edison Electric Institute, National Electrical Code, National fire Protection Association, National Electrical Safety Code and applicable instructions of manufacturers of equipment and material supplied for this project.
- C. Materials and Workmanship: All labor and materials of every kind shall be subject to the approval of the Engineer, who shall be afforded every facility for ascertaining the competence of such labor and examining such materials as they may deem necessary. Concealed work, handholes, and enclosures shall be reopened / opened at random as directed during inspections by the Engineer. Materials shall be new and shall bear the listed label of the Underwriters' Laboratories, Inc. Brand names and catalog numbers used in this specification indicate the standards of design and quality required. Substitution of other brands or catalog numbers shall conform to the requirements in the Bidding Documents. All high voltage work shall be performed by qualified electricians certified to work on high voltage systems.
- D. Record Drawings: The Contractor shall maintain an accurate and adequate record of each change as it occurs, regardless of how ordered.
- E. Drawings and Specification: This specification is intended to cover all labor, materials and standards of workmanship to be employed in the work indicated on the Drawings and called for in the specification or reasonably implied therein. The Drawings and specification supplement one another. Any part of the work mentioned in one and not represented in the other, shall be done the same as if it has been mentioned in both. The Contractor shall not make alterations in the Drawings and specification.
- F. Discrepancies and Interpretations:
 - 1. Should the Contractor find any discrepancies in or omissions from any of the documents or be in doubt as to their meaning, he shall advise the Engineer who will issue any necessary clarification within a time period which does not disrupt the progress of the work.
 - 2. All interpretation and supplemental instructions will be in the form of a written addenda to the Contract Documents.

3. Should any discrepancy arise from the failure of the Contractor to notify the Engineer, the higher quality or larger quantity of item shall prevail. The Engineer shall make the final interpretation and judgment.
 4. In the event of a discrepancy between small scale drawings and large scale details, or between the Drawings and specification, on which is in violation of any regulations, ordinances, laws or codes, the discrepancy, if known by the Contractor, shall be immediately brought to the attention of the Engineer for a decision before proceeding with the particular work involved. Work carried out disregarding these instructions will be subject to removal and replacement at the Contractor's expense.
- G. Symbols: The standard electrical symbols together with the special symbols, notes and instructions shown on the drawings indicate the work and outlets required and are all to be included as a part of this specification.
- H. Coordination: This specification is accompanied by Drawings which contain floor plans of the buildings, sections and elevations, and site plans indicating locations of all outlets, service runs, and other electrical apparatus. These locations are approximate and, before installing, the Contractor shall study the adjacent architectural details and actually make the installation in the most logical manner. Any outlet, equipment, feeder, and circuit may be relocated within ten feet before installation at the direction of the Engineer. The circuit routing is typical only and may be varied in any logical manner.

3.02 INSTALLATION

A. Grounding:

1. All services, metallic enclosures, raceways, and electrical equipment shall be grounded according to requirements of NEC Article 250. At building, 3/4" x 10' copper ground rods, Copperweld Steel Company, shall be driven with top 12" below finished grade and shall be connected together with bare copper wire buried 12" below finished grade to obtain a ground of 25 ohms or less as measured by three point pot method with an electric ground megger. Connect ground to nearest cold water pipe (located within 10' of entering the building), structural steel, and to building entrance equipment with bare copper. Ground and bond per the NEC and local authority having jurisdiction. Final connection to equipment, raceways, grounding type receptacles and other metallic parts directly exposed to ungrounded electric conductors shall be No. 8 AWG minimum, copper, NEC type TW, green insulation. Use approved bonding terminal at panels.
2. Bond and ground all feeder conduits to panelboard enclosures.

B. Wiring System:

1. Below grade or in slab, use Schedule 40 PVC. Provide separate ground wire and rise out of ground with Schedule 40 PVC. Transition to rigid steel conduit within 6" of finished grade.
2. GRC shall be utilized above finished ground floor where exposed in interior locations below 96 inches above finish floor, exposed in locations

under cover but not totally enclosed with walls, and exposed on the exterior of the building. GRC shall be supported off the finish floor with conduit support block.

3. All wiring shall be installed in conduits except as noted.
4. Conduit system shall be continuous from outlet to outlet and fitting to fitting so that electrical continuity is obtained between all conduits of the system.
5. Conduits cut square and inner edges reamed. Butt together evenly within couplings.
6. Make bends and offsets with hickey or conduit-bending machine. Do not use vise or pipe tee. Flattened or crushed conduit not acceptable.
7. Use of running threads not permitted. Where conduits cannot be joined by standard threaded couplings, approved water-tight conduit unions shall be used.
8. Cap conduits during construction with plastic or metal-capped bushings to prevent entrance of dirt and moisture. Swab all conduits and dry before installing wires. Provide removable watertight conduit seals on all conduits entering the building, or pad mounted equipment, where the conduit is connected to manholes, handholes, or other pad mounted equipment.
9. Pullstrings shall be placed in all empty / spare conduits ten feet in length or longer.
10. Install insulating bushings and two locknuts on each end of every conduit run at enclosures and boxes. Provide grounding bushings as required.

C. Conductors:

1. Mechanical means for pulling shall be torque-limiting type and not used for #2 AWG and smaller wires.
2. Pulling tension shall not exceed wire manufacturer's recommendations.
3. Where necessary, powdered soapstone may be used as a lubricant for drawing wires through conduit. No other means of lubricating will be allowed.
4. Form neatly in enclosures for minimum of crossovers. Tag all feeders and label all branch circuits in all enclosures and devices. Identify panel name and branch circuit number.
5. Color code feeder, branch circuit, and grounding conductors. Color for grounding conductors shall be green. Color for neutral conductors shall be white except for where neutrals of more than one branch circuit grouping are installed in the same raceway or enclosure, the other neutral shall be white with a colored stripe (other than green). The color coding for three-phase and single-phase circuits shall be as follows:

208Y/120V, 3-phase, 4-wire:

Black (Phase-A)

Red (Phase-B)

Blue (Phase-C)

480Y/277V, 3-phase, 4-wire:

Brown (Phase-A)

Orange (Phase-B)

Yellow (Phase-C)

120/240V, 1-phase, 3-wire:

Red and Black

D. Splicing of Wire and Cable:

1. Wires shall be formed neatly in enclosures and boxes.
2. Splices made according to NEC Article 110.
3. Splices shall be reinsulated. Remove all sharp points that can pierce tape. Use Minnesota Mining and Manufacturing Co. "Scotch" #33 tape, or pre-approved equal. Splices in pull boxes shall be water-tight.

E. Trench Excavation:

1. Dimensions and locations of trenches for pullboxes and ductlines shall be as indicated on drawings. Trench width and depths shall be sufficient to accommodate proper installation of conduit banks and cables.
2. Where a trench is excavated on slope, sides are to be vertical, and depth measured at lowest side. All measurements are to be based on final grades.
3. Bottom of trenches to be flat and smooth.
4. Trenches shall be widened at pullbox sites to permit proper entry of ducts.
5. All excavations for pullboxes in excess of the required depths shall be filled with concrete.
6. Sheathing and bracing as required shall be provided to support sides of excavations from cave-ins.
7. Excavated material may be placed alongside trench.

F. Backfill:

1. Backfilling shall be to finished grades indicated on accompanying drawings, and matching existing conditions.
2. Backfill material shall be completely free of wood or other debris.
3. Backfill material shall be placed in maximum of 12" layers in loose thickness before compacting. Backfill shall be thoroughly compacted with hand or mechanical tampers, and in no case shall tamping be accomplished by using the wheels or tracks of a vehicle.

G. Conduit and Duct Bank:

1. Bottom of trenches for all systems shall be clean, smooth and well graded prior to installation of conduits.

2. Saw cut, ream and taper ducts and conduits with manufacturers' approved tool.
3. Couplings and bells shall be tight to prevent entry of dirt into ducts and conduits.
4. Provide spacers to maintain proper separation between ducts.
5. Changes in direction of greater than 5° shall be accomplished by using special couplings or bends manufactured for this purpose. Where ducts enter pullboxes, they shall be terminated in end bells. Ducts shall be thoroughly cleaned before laying. When it is necessary to cut tapered end of duct at site, cut shall be made with saw and tapered with lathe designed to match original taper. Coordinate placement of duct runs with other utilities, structures, existing facilities and landscaping elements to avoid conflicts. When necessary, obtain acceptance from the Engineer for relocation and adjustments at no additional cost to the Owner.
6. Ducts shall be clean and free from debris and rubbish.
7. After each day's work, provide temporary conduit plugs at the end of conduit banks to prevent entry of dirt, rubbish, or debris.
8. Pass smooth bullet-shaped, blunt tip wooden test mandrel through the entire length of each duct or conduit to test for burrs and obstructions. Unless indicated otherwise, mandrel shall be 14" long and shall have diameter of 2" less than inside diameter of duct or conduit. If burrs or obstructions are encountered, that section shall be replaced at no additional cost to the Owner.
9. Unless indicated otherwise, install #12 AWG galvanized iron pulling wire or polypropylene cord in each conduit after testing.
10. Apply thin coat of sealing compound on ducts and conduits at couplings and bells.
11. Provide duct seals at each entry point into pullboxes to prevent water from flowing between pullboxes.

H. Finishing:

1. All cutting that may be required for complete installation of the electrical work shall be carefully performed, and all patching shall be finished in first-class condition by the Contractor.
2. Close unused knockouts in boxes or enclosures with metal cap that will maintain the rating of the box or enclosure.
3. Wipe clean all exposed raceways and enclosures with rag and solvent. Unfinished raceways and enclosures shall be primed and painted and finished to blend in with the surface it is mounted on. (Do not cover nameplates.) Factory finished enclosures shall not be painted, touch up where required.

I. Miscellaneous Details:

1. Complete all panel circuit directories, using typewriter. Verify "room" and "use" designations before typing.

2. Prime and paint all exposed conduits, hangers, and fasteners.
3. Furnish necessary test equipment and make all tests necessary to check for unspecified grounding, shorts and wrong connections. Correct faulty conditions, if any.
4. Tag all empty conduits in switchboard, panelboards, cabinets, at backboards, etc. and identify destination.
5. Provide arc flash warning labels on all electrical equipment as required by 2014 NEC Article 110.16 and 2015 NFPA-70E 130.5. The contractor shall attain all information required for the calculations, perform the calculations, and provide the labels at no additional cost.
6. Anchor all free-standing floor mounted electrical equipment, apparatus, and transformers. Provide additional bracing per the seismic conditions at the site.

3.03 TESTING AND INSPECTION

- A. If the Engineer discovers any errors, the Contractor, at his own expense, shall go over all similar portions of the entire job, taking the necessary or directed remedial action.
- B. After completion of all wiring, insulating resistance testing of all power and control circuits shall be performed with a 500-volt megger. The test on each circuit shall be performed for one minute in the presence of the Engineer or his representative, and a written test report of the results shall be submitted to the Engineer before acceptance can be obtained. Equipment which may be damaged during this test should be disconnected. The tests shall be performed with all other equipment connected to the circuit.
- C. After the electrical system installation is completed, and at such time as the Engineer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of these specifications. The test shall be performed in the presence of the Engineer or his authorized representative. The Contractor shall furnish all instruments, electric power and personnel required for the tests.
- D. Wherever test or inspection reveals faulty equipment or installation, the Contractor shall take corrective action, at his own expense, repairing or replacing equipment or installation as directed.

3.04 MEASUREMENT AND PAYMENT

- A. General: No separate payments will be made for the work covered by the separate section of the 16000 series of these specifications. All costs in connection with furnishing and installing of the various items in accordance with standard practice, the details shown on the drawings and in accordance with these specifications, shall be included in the lump sum price of which the item is a part.
- B. Compensation: Payment of the furnishing and installing of equipment will be made at the lump sum price bid of which the item is a part and shall be full

compensation for all work in accordance therewith, complete and finished in accordance with the drawings and specifications.

END OF SECTION

DIVISION 16 – ELECTRICAL

SECTION 16100 – SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEM

PART 1 – GENERAL

1.1 GENERAL CONDITIONS

This section covers the Supervisory Control and Data Acquisition (SCADA) system including equipment, wiring, adjustment and testing as indicated on the plans and specified herein.

As specified in Section 16000, Electrical. The provisions of these related sections apply to this section and work described in this section shall comply with them.

1.2 SUMMARY

- A. Provide all articles, materials, equipment, operations, and services herein or on Drawings, including all labor, materials, taxes, fees, insurance, and incidentals required to insure completion.
- B. Test Complete Installation: Installation shall be complete in every detail as specified and ready for use. Any item supplied by Contractor developing defects within one year of final acceptance by Owner shall be replaced by such materials, apparatus, or parts to make such defective portion of complete system conform to true intent and meaning of these Drawings and Specifications, at no cost to Owner.
- C. System shall be comprised of one (1) new RTU panel at the new Kau Water System site. The new RTU system at the site shall be mounted within an enclosure and shall be compatible to communicate, via radio link to the existing Master SCADA system at the existing DWS Baseyard. Basic function of the Kau Water System shall be to monitor on site conditions at the side and receive supervisory signals from the existing Master SCADA Station, and to telemeter the data back, via radio telemetry. This system shall require but not limited to the following work:
 - 1. Providing one (1) RTU at the new Kau Water System site, including but not limited to the following major equipment:
 - a. Siemens Simatic S7-1200 PLC 1214C DC/DC/DC with most current firmware version or approved equal
 - b. APC Smart-UPS RT 1500VA with Smart-UPS (spare) Battery Pack uninterruptible power supply unit or approved equal
 - c. 8-Port Unmanaged Ethernet switch
 - d. Siemens 10" HMI Operator Panel or approved equal
 - e. 4RF Aprisa SR+ Remote Station radio or approved equal
 - f. Two (2) Power Supplies

- g. One (1) Siemens TIA Portal V15 Professional Floating License
- 2. Providing required modifications and additions to the existing Master SCADA Station system at the existing DWS Baseyard for adding the new SCADA system at the Kau Water System site.
- 3. The SCADA communications systems shall be as indicated on the drawings and as follows:
 - a. Between the new Kau Water System site and the existing DWS Baseyard.
 - b. The system shall be used for transmitting alarms, status and telemetry, calculated data, diagnostic and error logging information from the remote RTU to the Master SCADA Station. Remote RTU shall also be able to upload any portion of their database to the Master SCADA Station upon request or event.
 - c. The Master SCADA System Computer shall be able to send to each remote RTU, commands and interrogation requests, and to download to the RTU the full Database, Application, Software and Parameters, via the communications channel.
 - d. The Master SCADA System Computer shall give the operators full visibility and control of the remote RTU operation including database changes, parameter changes, and full remote diagnostics, as well as source-level application monitoring for the system engineer.
 - e. The RTU shall be able to communicate and exchange data with each other and/or with hierarchies in the system and to inform the Master SCADA System about their activity.
 - f. Contractor shall verify conditions of existing SCADA equipment prior to bidding.
 - g. Contractor shall coordinate the planning and construction of the SCADA system (programming, I/O list, etc.) with the Owner.
 - h. The Contractor shall furnish and install a SCADA ready enclosure as indicated on the plans and specified herein.
 - i. Contractor shall furnish a list of SCADA points for approval prior to fabrication of the SCADA RTU panel.
- D. This system shall be an integrated system of hardware and firmware totally engineered, programmed, assembled and tested. System shall be complete with all appurtenances, whether specifically referenced herein or not, but which may be required for operation.
- E. During bidding and construction, Contractor shall coordinate his work with other trades to avoid omissions and overlapping responsibilities. Electrical contractor shall notify other trades and suppliers of project voltages, including control voltages.
- F. Work by Others: Instrument transmitters shall be provided by respective sections of this contract. Installation of equipment complete with power wiring and electric controls and interlock wiring shall be part of Electrical Work.

1.3 SUBMITTALS

- A. Submit in accordance with Section 01300 - SUBMITTALS.
- B. Shop drawings and catalogue cuts for substitute materials shall clearly specify compliance with and/or deviation from specified material. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; and "achieve the same end use and results as materials formulated in accordance with the referenced publications". Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance. Review of shop drawings and catalogue cuts shall not release Contractor from complying with intent of specification and drawings. Partial or incomplete submittals will be returned without review.
- C. Shop Drawings: Submit complete shop drawings and manufacturer's literature for the Engineer's review before any work is ordered or fabricated. All submittals shall bare the approval of the general contractor and the electrical contractor. Partial or incomplete submittals or submittals lacking the general contractor's and electrical contractor's approval will be returned without review. Submit manufacturer's literature for the following:
 - 1. SCADA system components and equipment
 - 2. Conductors and wiring
 - 3. Wiring and functional or block diagrams
 - 4. Radio equipment including transmitters, receivers, antennas, antenna cables, etc.
 - 5. Manufacturer's recommendations for installation
 - 6. Logic diagrams and ladder diagrams
 - 7. Manufacturer's recommended list of spare parts for a one-year period of operation
- D. As-Built Drawings: Submit as-built drawings as specified under Section 01700 - CONTRACT CLOSEOUT.

1.4 LOCAL SUPPORT

The manufacturer of the SCADA system supplied shall be represented by a company with offices in the State of Hawaii. This local office shall be capable of responding to requests for maintenance and repair to the system by having a technician skilled in the repair, maintenance and operation of the system at the job site within 24 hours of being notified. This local representative shall carry all spare parts which are recommended by the manufacturer.

PART 2 - PRODUCTS

2.01 GENERAL

Unless otherwise indicated, provide all first quality, new materials, free from any defects, in first class condition, and suitable for the space provided. New old stock

materials shall not be furnished as new material and shall not be accepted. Provide materials approved by UL wherever standards have been established by that agency. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

2.02 STANDARD PRODUCTS

Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer's latest standard design which conforms to the specifications.

2.03 SCADA SYSTEM CONTROL AND DESCRIPTION

The new system consists of one new SCADA/RTU system at the new Kau Water System site. The new site will communicate via radio link as indicated on the drawings to the existing Master SCADA system at the existing DWS Baseyard.

2.04 MATERIALS AND EQUIPMENT

- A. SCADA Ready Enclosure: The Contractor's SCADA work shall include terminating all telemetry inputs and outputs to terminal blocks within the SCADA enclosure as specified herein. Termination to an intermediate SCADA terminal cabinet shall not be accepted. Wiring shall be direct to SCADA enclosure. Termination shall be maintained tight to top, front of the enclosure's left side. Terminal blocks shall be neatly aligned in a single column and arranged in the following sequence from top to bottom: Power (Line), Power (Neutral), Power (Ground), Digital Inputs, Digital Outputs, Analog Inputs, and Analog Outputs. Terminal blocks shall be color coordinated in the following patterns:

SCADA ENCLOSURE TERMINAL BLOCK SCHEDULE

DESCRIPTION	COLOR	PART #
POWER (LINE)	BLACK	PHOENIX CONTACT UT4, 3045143
POWER (NEUTRAL)	WHITE	PHOENIX CONTACT UT4, 3045130
POWER (GROUND)	GREEN	PHOENIX CONTACT UT4, 3045156
DIGITAL INPUT	YELLOW	PHOENIX CONTACT UTTB4, 3035467
DIGITAL OUTPUT	GRAY	PHOENIX CONTACT UT2.5 - 3L, 3214259
ANALOG INPUT	BLUE	PHOENIX CONTACT UTTB4, 3044791
ANALOG OUTPUT	BLACK	PHOENIX CONTACT UTTB4, 3074282
ANALOG GROUND	GREEN	PHOENIX CONTACT UT2,5-PE 3044092
SPACER	RED	PHOENIX CONTACT UT4, 3045127

Terminal blocks shall maintain one block spacing between groups, with exception for Power (Line), Power (Neutral) and Power (Ground) which shall be grouped together. Further, Digital Input, Digital Output, Analog Input and Analog Output shall be segmented into groupings of eight (8) blocks with one block spacing between groupings. Provide ground terminal blocks for each Analog Input and Analog Output for landing the shield wire.

Contractor's wiring shall be terminated to left side of terminal blocks, with negative on the base tier and positive on the top tier for double-level terminal blocks; with normally open (N.O.) on the base tier, common on the 2nd tier, and normally closed (N.C.) on the top tier for multi-level terminal blocks. Wiring shall be marked at both ends with printed wire labels or printed heat shrink tags. Wiring shall be color coordinated as follow:

SCADA ENCLOSURE WIRING SCHEDULE

DESCRIPTION	COLOR
POWER (LINE)	BROWN
POWER (NEUTRAL)	WHITE
POWER (GROUND)	GREEN
D.C. (+)	RED
D.C. (-)	BLACK
DIGITAL OUTPUT (N.O.)	PURPLE
DIGITAL OUTPUT (COMMON)	YELLOW
DIGITAL OUTPUT (N.C.)	ORANGE
ANALOG INPUT (+)	BLUE
ANALOG INPUT (-)	GRAY
ANALOG GROUND	GREEN
ANALOG OUTPUT (+)	BLUE
ANALOG OUTPUT (-)	GRAY
ANALOG GROUND	GREEN

- B. The RTU equipment shall be microprocessor based, solid-state construction utilizing second source semiconductors, unless otherwise specified. Derate components to assure dependability and long-term stability. Provide printed or etched circuit boards of glass epoxy, hand or wave soldered, of sufficient thickness to prevent warping. Coat printed circuit boards in field-mounted equipment with 2 mils of solderable conformal coating complying with MIL-I-460-58B. Alignment and adjustments shall be noncritical, stable with temperature changes or aging and accomplished with premium grade potentiometers. Do not insert components of specially selected values into standard electronic assemblies to meet performance requirement. Use parts

indicated in instruction manuals, replaceable with standard commercial components of the same description without degrading performance of completed assembly. The RTU equipment shall be capable of communicating with the existing Master Station site PLC equipment. The RTU equipment shall be provided with a UPS system. The RTU shall have the capability to be expandable. RTU panel shall be fabricated by Dynatek, Inc.

- C. Operator Interface Touchscreen shall be installed within the SCADA Enclosure door, such that it may be operated without opening the cabinet door. Contractor shall confirm mounting location height with Owner prior to installation. Touchscreen shall have basic color screen.

Touchscreens shall monitor and control local functions of the RTU and communicate to the RTU using Ethernet communication, through a DIN rail mounted switch in the RTU panel.

The Touchscreen assembly shall be manufactured by Siemens and rated NEMA 4X. For facilities which only include a reservoir, a 10" Siemens KTP HMI panel with 640x480 resolution shall be specified.

- D. SCADA Hardware: The Contractor shall utilize as required the following list of approved RTU hardware. Hardware shall be the latest version at the time of construction, during the commencement of electrical portion of work.

1. Siemens S7-1200 1214C DC/DC/DC Firmware ≥ 4.1 , CPU
2. Siemens SM1221, Digital Input
3. Siemens SM1222, Digital Output
4. Siemens SM1231, Analog Input 8AI
5. Siemens SM1232, Analog Output
6. Siemens PM1207, Power Switch
7. Siemens XB008, 8-Port Unmanaged Industrial Ethernet Switch
8. Siemens KTP1000, 10" Panel
9. 24VDC, 3.5A Power Supply, Phoenix Contact QUINT-PS/1AC/24DC/3.5, PN# 2866747 (for radio and level transmitter only)
10. 24VDC, 5A Power Supply, Phoenix Contact QUINT-PS/1AC/24DC/5, PN# 2866750 (for radio and level transmitter only)
11. DIN Rails, 35mm x 7.5mm x 2000mm, Aluminum, Phoenix Contact PN# 0804681
12. Terminal Block, Black, Phoenix Contact UT4, PN# 3045143
13. Terminal Block, White, Phoenix Contact UT4, PN# 3045130
14. Terminal Block, Green, Phoenix Contact UT4, PN# 3045156
15. Terminal Block, Red, Phoenix Contact UT4, PN# 3045127
16. Terminal Block, Blue, Phoenix Contact UT4, PN# 3044791
17. Terminal Block, Yellow, Phoenix Contact UT4, PN# 3045114
18. Terminal Block, Gray, Phoenix Contact U2.5-3L, PN# 3214259

19. Terminal Block, Gray w/Black, Phoenix Contact UT2.5-3L, PN# 3214262
20. Fuse Terminal Block, Phoenix Contact, UK63-HESI, PN# 3004171
21. 1 Pole, 120/240VAC, 10A, Circuit Breaker, Rockwell 1489-A1C100
22. 2PDT, 24VDC Coil, 10A, Rockwell PN# 700-HC22Z24-3-4
23. Screw Terminal Base Socket, Black, Rockwell PN# 700-HN128
24. Relay Retainer Clips, Rockwell PN# 700-HN114
25. Diode, Motorola 1N4005
26. Terminal Block – Grounding Green/Yellow Phoenix Contact UT2,5-PE
27. Siemens 1241 Communications Module RS485/422 Modbus

E. Radio Equipment and Communications:

1. Communications Path Survey: The Contractor shall perform and furnish a communication path survey to determine the best system to communicate properly between the existing and new SCADA systems. The survey should simulate use of actual frequency and proposed equipment, and shall determine the gain margin for the proposed transmission path.
 - a. The survey shall include but not be limited to: a printout graph for each communication path which shall show the path profile, site elevations, site name, frequency, ERP, antenna type, distance between sites and predicted losses versus desired losses. The Contractor shall design the radio and communication system for at least 99.9% reliability.
 - b. Radio Path Study: A real world field study shall be performed by the Contractor to confirm the simulated computer path analysis.
2. Licensing: The Contractor shall be responsible for consulting with DWS for instruction on which existing FCC license and frequency to use. The Contractor shall prepare all paperwork required for FCC coordination and FCC licensing in accordance with the FCC Rules and Regulations governing the licensing of the proposed channels. One VHF frequency shall be required to accommodate the RTU reception and transmission to the central computer. The Contractor shall submit all FCC coordination requirements to the FCC for frequency approval. The Contractor shall be responsible for the payment of FCC license fee.
3. FCC Type Acceptance: All equipment related to the radio communication shall be FCC type accepted, indication authorization by the FCC to allow the equipment to be used by the licensee.

F. Radio Equipment: The Contractor shall furnish and install latest edition 4RF Aprisa SR+ Remote Station radios as required by the Kau Water System project. As a minimum, communication equipment and grounding shall be per *Motorola R56 – Standards and Guidelines for Communication Sites*. All existing communication equipment, materials and appurtenances shall be replaced. The reuse of existing materials shall be strictly prohibited.

G. Antenna and Accessories: All antenna hardware shall comply with FCC rules and governing the design characteristics and mounting requirements for licensed frequencies used in the SCADA system. In general, the remote station shall employ directional gain antennas. The central computer site will use an omni-directional gain antenna. Feedlines between antenna and SCADA ready

enclosures shall be solid, shielded coax (minimum 1/2" in diameter), low density, foam heliax. Each coax run shall be continuous and shall terminate with factory-installed connectors which are specifically designed for use with the above-described cable. The coax shall be run through conduit between the SCADA ready enclosure and the antenna. The conduit shall be a minimum of 2" nominal diameter, with no more than two (2) 90 degree bends with a minimum bend radius of 36 inches. The SCADA ready enclosure shall be equipped with a combination lightning arrestor and bulkhead fitting to allow coax termination through the enclosure. The feedline signal loss shall not exceed 1.55 dB (VHF) for each one hundred feet of run. The total connector loss at each site shall not exceed 1.0 db.

1. Grounding hardware kits specifically designed for use with the cable selected shall be furnished and installed by the Contractor.

2. Antenna Specifications:

Frequency Range	Match licensed channels
Nominal Impedance	50 Ohms
Forward Gain	6 -10 dB (Yagi)
Polarization	Vertical
Power Rating (min)	200 Watts
Materials	Aluminum/Stainless Steel
Construction	Welded
Mounting Clamps	2" O.D. Galvanized Pipe
Wind Rating	125 mph, 90 mph w/1/2" ice
Termination	Captive Type N
Lightning Protection	Direct ground connection

- H. Radio Hardware: The Contractor shall utilize as required the following list of approved RTU hardware. Hardware shall be the latest version at the time of construction. Provider shall provide one complete set of spare equipment.

1. 4RF Aprisa SR+ Remote Station Radio with Software Selectable Dual/Single Antenna Port
2. VHF Yagi Antenna, 167-174 MHz, 9.5 dB, 6 element, Sinclair SY206-SF5SNM
3. 1/2" Helical Coaxial Cable, Andrew LDF4-50a
4. 1-1/4" Helical Coaxial Cable, Andrew AVA6-50
5. 7/8" Helical Coaxial Cable, Andrew AVA5-50
6. Theft Deterrent Grounding Bar, Wireless Solutions HLGB-0412TSDNR-NH
7. 1-1/4" Coaxial Cable Grounding Kit, Sure Ground 114-06B2A
8. 7/8" Coaxial Cable Grounding Kit, Sure Ground 78-12B2U
9. 1/2" Coaxial Cable Grounding Kit, Sure Ground 12-12B2U
10. Lightning Arrestor, PolyPhaser VHF50HN

- 11. 900 MHz Yagi Antenna Elpro YU6-900, 9 dB Gain
- 12. Class H3 Wooden Pole, Western Red Cedar, Pressure Treated
- G. Instrumentation System Transmitter Power Supply: The power supply shall be mounted in the SCADA cabinet and deliver regulated 24-36 volts DC power at a maximum current recommended by the analog transmitter supplier. The unit shall operate on 117 volts AC at 50-70 Hz. Load regulation shall be 150 mV maximum from no-load to full-load current. Line regulation shall be 150 mV from 105 to 135 volts AC.
- H. See Drawings for additional information on the recommended materials and equipment for the SCADA system.

PART 3 - EXECUTION

3.01 CONSTRUCTION METHODS

- A. Flush indicators, selector switches, pushbutton switches, and pilot lights in a logical arrangement.
 - 1. Mount devices listed, shown, or required for a complete and operable system in accordance with device manufacturer's instructions, these specifications, and as recommended in NEMA PB1.1.
 - 2. Ground control panel to safety ground of power source.
 - 3. Analog signals must use shielded pairs cabling.

3.02 PROGRAMMING:

- A. Contractor shall coordinate all RTU programming with the Owner.
- B. The RTU supplier and Contractor shall provide the complete PLC and HMI software with appropriate licenses and license keys programming and documentation for RTU to comply with the requirements set forth herein.
- C. Contractor shall provide Owner with a copy of the implemented software.

3.03 COMMISSIONING: Instruments are to be commissioned under the direct supervision of a qualified representative of the instrument manufacturer. The Owner and or the Owner's representative shall have the right to witness any test, inspection, or calibration or start-up activity.

- A. Test and exercise each device to demonstrate correct operation, first individually, then collectively as a functional network. Apply continuously variable analog inputs to verify proper operation and setting of analog devices and discrete devices (i.e. switches, etc.).
- B. Unless otherwise specified, tests shall be made to cover at least five points: approximately 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of range. Individual device accuracy requirements shall be as specified by contract requirements or by published manufacturer accuracy specifications whenever contract requirements are not specified.
- C. If test results conflict with calibration, the Contractor shall recalibrate and repeat test until test results prove calibration to be correct.

- 3.04 TEST REPORT: Prepare a test report showing actual value, instrument value, 4-20 mA value (at the RTU) for each test, and range of the instrument. Each test shall bear the signature of the contractor's representative who supervised the tests and the manufacturer's representative. Three copies of these reports in bound sets label "CALIBRATION DATA" are to be furnished to the Owner's Representative.
- 3.05 ADDITIONAL START-UP SERVICES: The Contractor shall include an additional two days of programming time and the cost for the RTU's programmer to visit the site for one of the days in the bid. This time may be used at the discretion of the Owner for additional programming, changes, and/or training. This time is over and above the work necessary to provide a complete and operable system.
- 3.06 GUARANTEE: The SCADA system, equipment, materials, and associated items shall be guaranteed against defective parts and operation due to faulty material or workmanship during the period of one year following acceptance and final payment by the Engineer. The Contractor shall make all repairs or replacements necessary to accomplish the required performance within the time specified by the Engineer and agreed to by the Contractor.
- 3.07 MEASUREMENT AND PAYMENT
- A. General: No separate payments will be made for the work covered by the separate section of the 16000 series of these specifications. All costs in connection with furnishing and installing of the various items in accordance with standard practice, the details shown on the drawings and in accordance with these specifications, shall be included in the lump sum price of which the item is a part.
 - B. Compensation: Payment of the furnishing and installing of equipment will be made at the lump sum price bid of which the item is a part and shall be full compensation for all work in accordance therewith, complete and finished in accordance with the drawings and specifications.

END OF SECTION