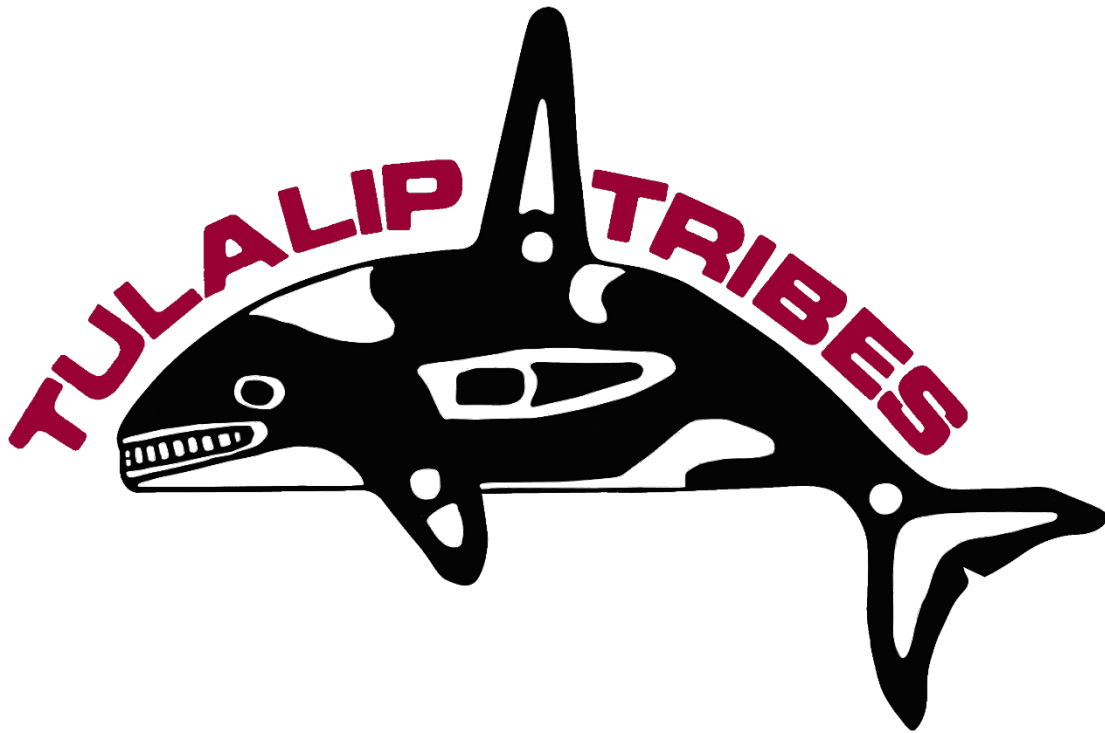


The Tulalip Tribes of Washington



**I-5 / 4th ST and 88th ST NE
Corridor Improvements**

Tulalip Tribes Project No. 2026-014

Contract Documents

June 2026

Volume 2 of 4

I-5 / 4th ST and 88th ST NE Corridor Improvements

Tulalip Tribes Project No.: 2026-014

Contract Documents

Prepared for

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June 2026

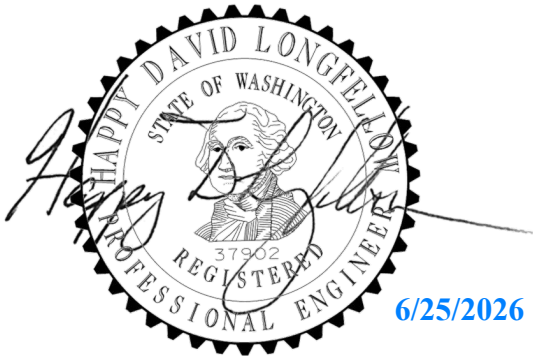
CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.



6/25/2026

Prepared by Steve Olling, PE



6/25/2026

Approved by Happy Longfellow, PE

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2 **SANITARY SEWER PUMP STATION**

3 **10-01 Description**

4 Division 10 is a technical specification completed in CSI format for the Pump Station only. See
5 the plans for the pay limits for the sanitary sewer pump station relocation.

6 **ALL OTHER CONTRACT LANGUAGE / SPECIFICATIONS APPLY FOR THIS WORK AND**
7 **SHOULD NOT BE READ AS STAND-ALONE SPECIFICATIONS FOR THE SEWER PUMP**
8 **STATION.**

9 **10-02 Materials**

10 The materials required for the demolition of the existing sanitary sewer pump station and
11 relocation to the new site are defined on the associated contract drawings and the CSI
12 specifications included in this division.

13
14 **10-03 Construction Requirements**

15 The construction requirements for the demolition of the existing sanitary sewer pump station and
16 relocation to the new site are defined on the associated contract drawings and the CSI
17 specifications included in this division.

18 **10-04 Measurement**

19 The Bid Item in the Proposal for "Pump Station Relocation" includes construction of a complete
20 sanitary sewer pump station and appurtenances, including the demolition if the existing sanitary
21 sewer pump station. This Work is described in the CSI Format Technical Specifications within this
22 Division.

23 The Bid Item in the Proposal for "Electrical Controls for Pump Station Relocation" includes
24 construction for all electrical elements, including connection to the Snohomish County PUD
25 Transformer.

26 No specific unit of measure will apply to the lump sum item "Pump Station Relocation" and
27 "Electrical Controls for Pump Station Relocation"

28 **10-05 Payment**

29 The lump sum price for "Pump Station Relocation" shall be full payment for all labor and materials
30 for a complete and operable pump station as shown on the Plans, within the Pump Station
31 Payment Limits identified on the Plans.

32 This Work shall include, but not be limited to, site preparation (furnishing and installing erosion
33 control at the pump station demolition and relocation site and removing all trees and vegetation
34 within the clearing and grubbing limits), demolition of the existing pump station (existing piping,
35 top section of existing wet well, valve vault and piping, concrete block wall, concrete slabs and
36 asphalt paving), dewatering, excavation, shoring or extra excavation, foundation and ballasting

1 material, furnishing and installing the wet well structure (including the top slab with hatch and
2 concrete channeling), valve vault structure, furnishing and installing the extension of the existing
3 gravity sewer pipe to the new wet well, furnishing and installing pumps and pump appurtenances,
4 wet well vent, pressure force main piping including valves, pipe wall penetration seals, pipe
5 penetration concrete blocking, pipe supports, fittings, combination air/vacuum release valve and
6 piping, flowmeter, and the connection to the existing force main, furnishing and installing vault
7 drain piping (including the floor drain, trap, and check valve), furnishing and installing pump station
8 concrete pads, furnishing and installing a new top section with ring and cover on the existing
9 pump station wet well to serve as a gravity sewer maintenance hole with a ring and cover access
10 set flush to the grade of the new pedestrian ramp, furnishing and installing pump station fencing
11 and gate, furnishing testing, commissioning, Operational and Maintenance manuals.

12 The lump sum price for “Electrical Controls for Pump Station Relocation” shall be full payment for
13 all labor and materials for include all necessary work, equipment, materials, labor, and incidentals
14 for the Pump Station Relocation electrical work as shown on the Plans, within the Pump Station
15 Payment Limits identified on the Plans.

16 Demolition of existing panels, conduit, power service, power service transformer (including
17 coordination with SnoPUD), furnishing and installing site electrical, including conduit and wire;
18 electrical distribution panels and switches, pump station electrical service equipment; manual
19 transfer switch and receptacle; pump control panel, termination panel, mini-power zone and
20 enclosure, local disconnect switches and junction boxes, furnishing all pump station equipment
21 testing, integration, and programming.

22 **10-06 CSI Specifications**

23 The following are the CSI specifications included in this Division:

24 **Division 01 – General Requirements**

25 01 11 00 Summary of Work
26 01 12 16 Work Sequence
27 01 33 00 Submittal Procedures
28 01 43 33 Manufacturer's Services
29 01 65 10 Testing, Training, and Commissioning
30 01 77 00 Closeout Procedures
31 01 78 23 Operation and Maintenance Data
32 01 99 99 Forms

33 **Division 02 – Existing Conditions**

34 02 41 00 Demolition

35 **Division 03 – Concrete**

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37 03 30 01 Cast-In-Place Concrete
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39	40 70 00	Instrumentation and Controls, General Requirements

- 1 40 70 00.01 Instrumentation Schedule
- 2 40 71 10 Magnetic Flow Meters
- 3 40 71 20 Level Instruments
- 4 40 78 00 Panel-Mounted Instruments

5 **TECHNICAL SPECIFICATIONS FOLLOW**

1 **SECTION 01 11 00**

2 **SUMMARY OF WORK**

3 **PART 1 – GENERAL**

4 **1.01 WORK COVERED BY CONTRACT DOCUMENTS**

5 A. In general, the WSDOT Standard Specifications and Special Provisions apply to the
6 improvements to the pump station relocation work at the intersection of 88th Street NE
7 and 34th Avenue NE.

8 B. The Technical Specifications prepared in Construction Specifications Institute (CSI) style
9 also apply exclusively to the pump station relocation work at the intersection of 88th Street
10 NE and 34th Avenue NE. The term Specifications shall include those described in
11 Paragraphs 1.01 A and B and considered part of the Contract Documents. Where a conflict
12 exists within the Contract Documents, the precedence shall be per Section 1-04.2 of the
13 Special Provisions.

14 C. The work is described in the Special Provisions Section 1-09.14 and summarized as
15 follows:

16 1. Procurement, delivery, and installation of pumps, spare parts, and accessories; wet
17 well; vaults; valves; piping; fittings; concrete slabs and pads; fencing with gate;
18 electrical equipment and control equipment; and miscellaneous equipment and
19 materials required to perform the work as shown on the Contract Drawings and as
20 described in the Specifications.

21 2. Implementation of TESC measures at the site.

22 3. Development and implementation of Contractor designed shoring.

23 4. Construction of a permanent 10-inch pipe extension to the new wet well.

24 5. Construction of a connection of the relocated pump station to the existing force main
25 and abandonment of that portion of the existing force main between the existing pump
26 station and the new connection.

27 6. Construction of a water service with backflow preventor, hot box, and yard hydrant.

28 7. Modification of the existing wet well to provide concrete channeling to route flow
29 through to the new pump station and modification of the top section to accommodate
30 the new pedestrian ramp.

31 8. Clearing and grubbing of existing trees and plants to accommodate the new pump
32 station relocation.

33 9. Demolition of the existing pump station walls, fencing, pump station, electrical
34 equipment, piping, conduit, and handholes associated with the Construction of
35 supporting electrical improvements for the pump station.

- 1 10. Enunciation of new pump station status and alarm with a cellular remote telemetry
2 unit.
- 3 11. Startup, testing, and commissioning of the new equipment at the relocated pump
4 station.
- 5 12. Training of Owner's employees.
- 6 13. Site restoration.
- 7 14. Provision of O&M Manuals.
- 8 15. Provision of detailed as-built red-line mark-ups for as-built drawings.
- 9 16. Completion of punch-list items.

10 **1.02 SPECIAL PROJECT CONSIDERATIONS**

11 A. Coordination with Others:

- 12 1. The work is part of an overall road improvement project and shall be coordinated in
13 such a manner as not to delay other work stages on the overall project.
- 14 2. The Contractor shall conduct its on-site operations so as to cause a minimum of
15 interference businesses and to maintain access to those businesses at all times.

16 **1.03 OWNER USE OF THE PROJECT SITE**

- 17 A. The Owner may utilize all or part of the existing site/facilities during the entire period of
18 construction to conduct the Owner's normal operations. The Contractor shall cooperate
19 and coordinate with the Engineer to facilitate the Owner's operations and to minimize
20 interference with the Contractor's operations at the same time. In any event, the Owner
21 shall be allowed access to the project site at all times during the period of construction.

22 **1.04 WASTEWATER FACILITIES**

- 23 A. The Contractor is responsible for the safety of its own staff on site including but not limited
24 to confined space training and coordinating with the Owner for procedures.
- 25 B. The work will be in proximity to raw wastewater. The Contractor certifies that he is
26 experienced and qualified to anticipate and meet the safety and health requirements of
27 this project.
- 28 C. Workers involved with on-site work may be exposed to disease producing organisms in
29 wastewater. The Contractor shall require its personnel to observe proper
30 hygienic precautions.
- 31 D. Solvents, gasoline, and other hazardous materials can enter the existing sewage system
32 with incoming sewage, and, therefore, certain areas are hazardous to open flame, sparks,
33 or unventilated occupancy. The Contractor shall take measures to ensure its personnel
34 observe proper safety precautions when working in these areas.

1 **1.05 CONSTRAINTS**

2 A. The Contractor shall isolate the existing wet well from the gravity system with a plug in the
3 inlet pipe to the wet well.

4 B. Operational and Scheduling Constraints: The following operational and scheduling
5 constraints apply unless otherwise specified:

6 1. Sanitary Sewer:

7 a. The existing sanitary sewer gravity infrastructure will not cease operation during
8 any construction activities as a part of this Contract. As needed, Contractor shall
9 provide temporary bypass pipe to accommodate work on the overflow weir
10 assembly. This work shall be performed during the Lower Flow Season defined in
11 Section 01 12 16, "Work Sequence."

12 C. Access shall be maintained for Owner operation and maintenance activities.

13 **1.06 FORMAT**

14 A. The Technical Specifications are organized on the format promulgated by the Construction
15 Specifications Institute (CSI Format) style.

16 B. This format assigns permanent numbers to all divisions and sections and, so far as
17 possible, assigns all products, processes, activities, and construction requirements
18 permanent places in the Specifications.

19 C. These Specifications are written in imperative mood and streamlined form. This imperative
20 language is directed to the Contractor, unless specifically noted otherwise. The words
21 "shall be" are included by inference where a colon (:) is used within sentences or phrases.

22 **PART 2 – PRODUCTS (NOT USED)**

23 **PART 3 – EXECUTION (NOT USED)**

24 **END OF SECTION**

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1 **1.03 SUBMITTALS**

2 A. Provide the following submittals in accordance with Section 01 33 00,
3 "Submittal Procedures:"

4 1. Advanced notices of equipment shutdowns or restricted use.

5 2. For each milestone, submit a written statement to notify the Project Representative
6 when Contractor believes the milestone is complete.

7 3. To make use of Exceptions to Operational Constraints shown in this specification,
8 submit weather forecast to document anticipation of dry weather conditions, prior to
9 use of the listed exception.

10 4. Submit anticipated traffic or site circulation impacts to Engineer and Owner.

11 **1.04 COMPLETION TIMES**

12 A. Achieve Substantial Completion and Final Acceptance as required in Section 1-05 of the
13 Special Provision shall be no later than the dates stated in the Call for Bids, after notice to
14 proceed to the Contractor, unless otherwise approved in writing by the Owner.

15 **1.05 WORK SEQUENCE**

16 A. General: The Contractor is responsible for determining the sequence of work within the
17 constraints of this Contract.

18 B. Prior to beginning of work at that changes the existing site conditions, the following shall
19 be completed for the specific pump station site:

20 1. Submit and obtain a "No Exceptions" response on the submittal of a project-specific
21 Health and Safety Plan prior to start of fieldwork.

22 2. Complete all required and specified erosion and sedimentation control measures.

23 3. Meet with the Owner's Operations and Maintenance staff to understand station and
24 gravity sewer operations, flow, safety requirements, and communication issues.

25 C. The pump station relocation is needed to accommodate the traffic revisions to the adjacent
26 intersection. The Contractor shall sequence the work so as not to interfere with or delay
27 the overall project construction. The following is a suggested generalized sequence of
28 construction and commissioning:

29 1. Construction of the pump station improvements:

30 a. Isolating existing wet well with mechanical plug.

31 b. Implementation of temporary erosion and sedimentation best management
32 practices.

33 c. Clearing and demolition work.

- 1 d. Construction of vaults, valves, piping, pumps, other mechanical equipment,
2 electrical equipment and systems, and instrumentation.
- 3 e. Implementation of the temporary sanitary sewage bypass in the overflow structure
4 and making improvements to the weir assembly.
- 5 f. Installation, testing, and commissioning of the mechanical and electrical systems.
- 6 g. Complete final site restoration and clean-up as needed to accommodate next
7 phase in traffic improvements.

8 **1.06 CONSTRAINTS**

- 9 A. See Section 01 11 00, "Summary of Work," for project constraints.
- 10 B. Notification: For all equipment and facility shutdowns and use restrictions, provide the
11 Project Representative with advanced notice, and Contractor shall receive approval from
12 the Project Representative, prior to the shutdown or restricted use. Provide the Owner a
13 minimum preliminary advanced notification of 7 days and 48 hours confirmed notice prior
14 to shutdowns and use restrictions.

15 **1.07 HOURS OF WORK**

- 16 A. Working hours for this Contract shall be per Section 1-08.0(2) of the Special Provisions.

17 **1.08 INCENTIVES AND LIQUIDATED DAMAGES**

- 18 A. Incentives: Not used in this Contract.
- 19 B. Liquidated Damages for failure to achieve milestones, shall be assessed in accordance
20 with Section 1-08.9 of the Special Provisions.

21 **PART 2 – PRODUCTS (NOT USED)**

22 **PART 3 – EXECUTION (NOT USED)**

23 **END OF SECTION**

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- 1 I. Incomplete Submittal Submissions:
- 2 1. Engineer will return the entire submittal for Contractor's revision/correction and
3 resubmission.
- 4 2. Submittals that do not clearly bear Contractor's specific written indication of Contractor
5 review and approval of submittal or that are transmitted with an unsigned or uncertified
6 submission form or as may otherwise be required will be returned to Contractor
7 unreviewed.
- 8 J. Nonspecified Submissions: Submissions not required under these Contract Documents
9 and not shown on submissions will not be reviewed and will be returned to the Contractor.
- 10 K. Engineer's Review: Engineer will act upon Contractor submittal and transmit response to
11 Contractor not later than 21 days after receipt, unless otherwise specified. Resubmittals
12 will be subject to the same review time.
- 13 L. Schedule Delays:
- 14 1. No adjustment of contract times or price will be allowed due to Engineer's review of
15 submittals, unless all of the following criteria are met:
- 16 a. Contractor has notified Engineer in writing that timely review of submittal in
17 question is critical to progress of Work and has received Engineer's written
18 acceptance to reflect such on current accepted submissions and progress
19 schedule. Written agreement by the Engineer to reduce submittal review time will
20 be made only for unusual and Contractor-justified reasons. Acceptance of a
21 progress schedule containing submittal review times less than specified or less
22 than agreed to in writing by Engineer will not constitute Engineer's acceptance of
23 the reduced review times.
- 24 b. Engineer has failed to review and return first submission of a submittal within
25 agreed time indicated on current accepted schedule of submissions or, if no time
26 is indicated thereon, within 21 days after receipt.
- 27 c. Contractor demonstrates that delay in progress of Work is directly attributable to
28 Engineer's failure to return submittal within time indicated and accepted
29 by Engineer.
- 30 2. No adjustment of contract times or price will be allowed due to delays in progress of
31 Work caused by rejection and subsequent resubmission of submittals, including
32 multiple resubmissions.

33 **1.02 SHOP DRAWINGS AND SAMPLES**

- 34 A. Copies:
- 35 1. Electronic searchable PDF file.
- 36 2. Samples: Two, unless otherwise specified in individual specification sections.

- 1 B. General: Submit to Engineer and Owner as required by individual specification sections.
- 2 C. Identify and Indicate:
- 3 1. Pertinent drawing sheet(s) and detail number(s), products, units and assemblies, and
4 system or equipment identification or tag numbers.
- 5 2. Critical field dimensions and relationships to other critical features of Work.
- 6 3. Samples: Source, location, date taken, and by whom.
- 7 4. Each deviation or variation from Contract Documents.
- 8 5. Where spare parts are to be provided under individual specification sections, indicate
9 the lead time for delivery of all spare parts and a list of suppliers of the spare parts.
- 10 D. Design Data: When specified, provide project-specific information as required and as
11 necessary to clearly show calculations, dimensions, logic and assumptions, and
12 referenced standards and codes upon which design is based.
- 13 E. Foreign Manufacturers:
- 14 1. When proposed, include the following additional information:
- 15 a. Names and addresses of at least two companies closest to Project that maintain
16 technical service representatives.
- 17 b. List of local spare parts and accessories available for proposed equipment.
- 18 F. Warranty Information:
- 19 1. Certificate or Statement of Warranty.
- 20 2. Start date of Warranty.
- 21 G. Preparation:
- 22 1. Format: Whenever possible, schedule for and combine Shop Drawings and samples
23 required for submission in each specification section into a single submittal package.
- 24 2. Present in a clear and thorough manner and of sufficient detail to show kind, size,
25 arrangement, and function of components, materials, and devices and compliance
26 with Contract Documents. Identify details by reference to sheet and detail, and
27 schedule or room numbers as shown on Drawings.
- 28 3. Sheet Sizes: 8-1/2 inches by 11 inches or multiples thereof to a maximum of 22 inches
29 by 34 inches.
- 30 4. Piping Systems: Drawn to scale.
- 31 5. Product Data: Clearly mark each copy to identify pertinent products or models and
32 show performance characteristics and capacities, dimensions and clearances

1 required, wiring, or piping diagrams and controls, and external connections,
2 anchorages, and supports required.

3 6. Equipment and Component Titles: Identical to title shown on Drawings.

4 7. Manufacturer's standard schematic drawings and diagrams as follows:

5 a. Modify to delete information that is not applicable to work.

6 b. Supplement standard information to provide information specifically applicable
7 to work.

8 H. Shop Drawing Disposition:

9 1. Engineer will review, mark, and stamp as appropriate and distribute marked up copies
10 as noted:

11 a. No Exception Taken (for incorporation in Work):

12 1) One copy furnished Owner.

13 2) One copy furnished Resident Project Representative.

14 3) One copy retained in Engineer's file.

15 4) Remaining copies returned to Contractor appropriately annotated.

16 5) Contractor may begin to implement activities to incorporate specific product(s)
17 or Work covered by submittal.

18 b. Make Corrections Noted (for incorporation in work):

19 1) One copy furnished Owner.

20 2) One copy furnished Resident Project Representative.

21 3) One copy retained in Engineer's file.

22 4) Remaining copies returned to Contractor appropriately annotated.

23 5) Contractor may begin to implement activities to incorporate product(s) or work
24 covered by submittal, in accordance with Engineer's notations.

25 c. Rejected:

26 1) One copy furnished Owner.

27 2) One copy furnished Resident Project Representative.

28 3) One copy retained in Engineer file.

29 4) Remaining copies returned to Contractor appropriately annotated.

- 1 5) Contractor shall make corrections or develop replacement and resubmit (in
2 same manner and quantity as specified for original submission).
- 3 6) Submittal is not satisfactory and Contractor may not incorporate specific
4 product(s) or conduct Work covered by submittal.
- 5 d. Revise and Resubmit:
- 6 1) One copy furnished Owner.
- 7 2) One copy furnished Resident Project Representative.
- 8 3) One copy retained in Engineer's file.
- 9 4) Remaining copies returned to Contractor appropriately annotated.
- 10 5) Contractor shall resubmit entire submittal after making required revisions (in
11 same manner and quantity as specified for original submission).
- 12 6) Submittal is not satisfactory and Contractor may not incorporate specific
13 product(s) or conduct Work covered by submittal.
- 14 e. Submit Specified Item:
- 15 1) One copy furnished Owner.
- 16 2) One copy furnished Resident Project Representative.
- 17 3) One copy retained in Engineer's file.
- 18 4) Remaining copies returned to Contractor appropriately annotated.
- 19 5) Contractor shall submit missing portions (in same manner and quantity as
20 specified for original submission).
- 21 6) Submittal is not satisfactory and Contractor may not incorporate specific
22 product(s) or conduct Work covered by submittal, unless otherwise noted in
23 the Engineer's review comments.
- 24 I. Sample Disposition: Same as shop drawing disposition. Samples will not be returned.

25 **1.03 ADMINISTRATIVE SUBMITTALS**

- 26 A. Electronic searchable PDF file.
- 27 B. Submit to Owner. Owner will transmit Engineer copies as appropriate.
- 28 C. Description:
- 29 1. Submittals that are not Shop Drawings or samples, or that do not reflect quality of
30 product or method of construction.

- 1 2. May include, but is not limited to, those submittals identified below:
- 2 a. Applications for Payment.
- 3 b. Progress Reports and Quantity Charts: As may be required in, “Progress
- 4 Schedule” in the Special Provisions.
- 5 c. Progress Schedule(s): As may be required in, “Progress Schedule” in the Special
- 6 Provisions. Schedule of Values: Meet the requirements “Schedule of Values”
- 7 below.
- 8 d. Training Materials: Meet the requirements of individual equipment specifications.
- 9 e. Submittals Required by Laws, Regulations, and Governing Agencies:
- 10 1) Submit promptly notifications, reports, certifications, payrolls, and otherwise as
- 11 may be required directly to the applicable federal, state, or local governing
- 12 agency or their representative.
- 13 2) Transmit to Engineer for Owner’s records one copy of correspondence and
- 14 transmittals (to include enclosures and attachments) between Contractor and
- 15 governing agency.
- 16 f. Disposition: When appropriate, Engineer will review, stamp, and indicate
- 17 requirements for resubmission or acceptance on submittal as follows:
- 18 1) No Exceptions Taken:
- 19 a) Schedules: Indicates that schedules provide for the orderly progression of
- 20 the Work to completion within any specified milestones and the contract
- 21 times, but such acceptance will neither impose on Engineer’s responsibility
- 22 for the sequencing, scheduling, or progress of the Work nor interfere with
- 23 or relieve Contractor from Contractor’s full responsibility therefore.
- 24 b) Acceptance of other administrative submittals will indicate that submittal
- 25 conforms to intent of Contract Documents as to form and substance.
- 26 c) Contractor may proceed to perform submittal-related Work.
- 27 d) One copy furnished Owner.
- 28 e) One copy furnished Resident Project Representative.
- 29 f) One copy retained in Engineer’s file.
- 30 g) Remaining copies returned to Contractor appropriately annotated.
- 31 2) Rejected:
- 32 a) One copy furnished Owner.

- 1 b) One copy retained in Engineer's file.
- 2 c) Remaining copies returned to Contractor appropriately annotated.
- 3 d) Contractor shall revise/correct or develop replacement and resubmit.

4 D. Schedule of Values:

- 5 1. Format: Identify each line item in the Schedule of Values with number and title of the
6 major specification sections. Submit typed Schedule of Values on 8-1/2 by 11-inch
7 paper; Contractor's standard form or media-driven printout will be considered on
8 request.
- 9 2. At preconstruction meeting, submit to the Engineer a preliminary Schedule of Values.
10 After approval by Engineer, submit to the Engineer a Schedule of Values (preferably
11 in Microsoft Excel format), at least 15 days prior to submitting first Application for
12 Payment.
- 13 3. The Schedule of Values shall assign a fair, reasonable, and equitable dollar value for
14 each activity on the Contractor's Progress Schedule. The Schedule of Values shall
15 include anticipated progress payments for each item in the Bid Form through the final
16 payment. In addition, a detailed breakdown of lump sum prices shall be included in the
17 Schedule of Values.
- 18 4. The detailed breakdown of the lump sum shall list prices for the following unless
19 otherwise included as a bid item:
 - 20 a. Bonds and Insurance Premiums.
 - 21 b. Mobilization.
 - 22 c. Shoring.
 - 23 d. Excavation and Earthwork.
 - 24 e. Erosion Control.
 - 25 f. Reinforcing Steel.
 - 26 g. Concrete.
 - 27 h. Precast Concrete.
 - 28 i. Masonry.
 - 29 j. Miscellaneous Metals.
 - 30 k. Equipment.
 - 31 l. Packaged Equipment.

- 1 m. Installation of Sewage Pumps.
- 2 n. Installation of Generators.
- 3 o. Installation of Electrical Panels.
- 4 p. Mechanical – Process Piping, Valves, and Supports.
- 5 q. Electrical.
- 6 r. Instrumentation and Controls.
- 7 s. Operation and maintenance manual.
- 8 t. Testing.
- 9 u. Start-up.
- 10 v. Training.
- 11 w. Record Drawings.
- 12 x. Close Out.
- 13 y. Demobilization.
- 14 z. Other items as appropriate to the Work and as approved by the Engineer.
- 15 5. The Schedule of Values shall specifically indicate installed cost for materials and
16 equipment for each bid item.
- 17 6. Each activity's assigned value shall consist of labor, equipment and materials cost and
18 a prorate contribution to overhead and profit. Breakdown shall be so organized as to
19 facilitate assessment of Work and payment of subcontractors.
- 20 7. The sum of the assigned values shall equal the lump sum price of the activity.

21 **1.04 QUALITY CONTROL SUBMITTALS**

- 22 A. Electronic searchable PDF file .
- 23 B. Submit to Owner. Owner will provide copies to Engineer as appropriate.
- 24 C. Certificates:
- 25 1. Certificates of Successful Testing or Inspection: Submit when testing or inspection is
26 required by laws and regulations or governing agency or specified in the individual
27 specification sections.

- 1 2. Manufacturer's Installation Certification Form: As required in Section 01 43 33,
2 "Manufacturers' Services." Coordinate with Section 01 65 10, "Testing, Training, and
3 Commissioning."
- 4 D. Operation and Maintenance Manual: As required in Section 01 78 23, "Operation and
5 Maintenance Data."
- 6 E. Statements of Qualification: Evidence of qualification, certification, or registration. As
7 required in these Contract Documents to verify qualifications of professional land
8 surveyors, engineers, materials testing laboratories, specialty subcontractors, trades,
9 consultants, installers, and other professionals.
- 10 F. Field Samples: Provide as required by individual specifications and as may be required
11 by Engineer during progress of Work.
- 12 G. Written Test Reports of Each Test and Inspection:
- 13 1. As a minimum, include the following:
- 14 a. Date of test and date issued project title and number, testing laboratory name,
15 address, telephone number, and name and signature of laboratory inspector.
- 16 b. Date and time of sampling or inspection and record of temperature and
17 weather conditions.
- 18 c. Identification of product and specification section, location of sample, test, or
19 inspection in the Project, type of inspection or test with referenced standard code,
20 certified results of test.
- 21 d. Compliance with Contract Documents and identifying corrective action necessary
22 to bring materials and equipment into compliance.
- 23 e. Provide an interpretation of test results, when requested by Engineer.
- 24 H. Disposition:
- 25 1. Engineer will review, stamp, and indicate requirements for resubmission or acceptance
26 on submittal as follows:
- 27 a. No Exceptions Taken:
- 28 1) Acceptance will indicate that submittal conforms to intent of Contract
29 Documents as to form and substance.
- 30 2) Contractor may proceed to perform submittal-related Work.
- 31 3) One copy furnished Owner.
- 32 4) One copy furnished Resident Project Representative.
- 33 5) Once copy retained in Engineer's file.

- 1 6) Remaining copies returned to Contractor appropriately annotated.
- 2 b. Rejected:
- 3 1) One copy furnished Owner.
- 4 2) One copy retained in Engineer's file.
- 5 3) Remaining copies returned to Contractor appropriately annotated.
- 6 4) Contractor shall revise/correct or develop replacement and resubmit.

7 **1.05 CONTRACT CLOSEOUT SUBMITTALS**

- 8 A. General: Meet requirements of Section 01 77 00, "Closeout Procedures."
- 9 B. Submit to Engineer.
- 10 C. Disposition:
 - 11 1. Engineer will review, stamp, and indicate requirements for resubmission or acceptance
 - 12 on submittal as follows:
 - 13 a. No Exceptions Taken:
 - 14 1) Acceptance will indicate that submittal conforms to intent of Contract
 - 15 Documents as to form and substance.
 - 16 2) Contractor may proceed to perform submittal-related Work.
 - 17 3) One copy furnished Owner.
 - 18 4) One copy furnished Resident Project Representative.
 - 19 5) One copy retained in Engineer's file.
 - 20 6) Remaining copies returned to Contractor appropriately annotated.
 - 21 b. Rejected:
 - 22 1) One copy furnished Owner.
 - 23 2) One copy retained in Engineer's file.
 - 24 3) Remaining copies returned to Contractor appropriately annotated.
 - 25 4) Contractor shall revise/correct or develop replacement and resubmit.

1 PART 2 – PRODUCTS (NOT USED)

2 PART 3 – EXECUTION (NOT USED)

3 END OF SECTION

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- 1 3. Assistance during functional and performance testing and startup demonstration, and
2 until product acceptance by the Owner.
- 3 4. Training of Owner's personnel in the operation and maintenance of respective product
4 as required.
- 5 5. Completion of Manufacturer's Certificate of Proper Installation with applicable
6 certificates for proper installation and initial, interim, and final test or service.

7 **1.05 TRAINING SCHEDULE**

- 8 A. List specified equipment and systems with respective manufacturers that require training
9 services or manufacturers' representatives and show:
 - 10 1. Estimated dates for installation completion.
 - 11 2. Estimated dates for start-up testing.
 - 12 3. Estimated training dates to allow for multiple sessions when several shifts are involved.
- 13 B. Adjust training schedule to ensure training of appropriate personnel as deemed necessary
14 by Owner.

15 **1.06 TRAINING OWNER'S PERSONNEL**

- 16 A. Furnish trained, articulate personnel to coordinate and expedite training, to be present
17 during training coordination meetings with Owner, and familiar with operation and
18 maintenance manual information specified in Section 01 78 23, "Operation and
19 Maintenance Data."
 - 20 B. Furnish manufacturers' representatives for detailed classroom and hands-on training to
21 Owner's personnel on operation and maintenance of specified product (system,
22 subsystem, component) and as may be required in applicable specifications.
 - 23 1. All training sessions for Owner's personnel shall be scheduled to take place on a date
24 and time coordinated with Owner.
 - 25 2. Training sessions may be videotape recorded by Owner at Owner's expense.
 - 26 3. Provide two training sessions for operators in order to allow all operators to attend one
27 training session while other operators continue operations. Operations training
28 sessions shall follow the following outline:

29 **1.07 GENERAL OUTLINE FOR MANUFACTURER PRESENTATIONS**

- 30 1. Familiarization:
 - 31 a. Show catalog, parts lists, drawings, etc., in the plant files and operation and
32 maintenance manuals.
 - 33 b. Check out the installation of the specific equipment items.

- 1 c. Demonstrate the unit and show that all parts of the Specifications are met.
- 2 d. Answer questions.
- 3 2. Safety:
 - 4 a. Point out safety references.
 - 5 b. Discuss proper precautions around equipment.
- 6 3. Operation:
 - 7 a. Point out reference literature.
 - 8 b. Explain all modes of operation (including emergency).
 - 9 c. Check out Owner's personnel on proper use of the equipment (let them do it).
- 10 4. Preventive Maintenance (PM):
 - 11 a. Pass out PM list including:
 - 12 1) Reference material.
 - 13 2) Daily, weekly, monthly, quarterly, semi-annual, and annual jobs.
 - 14 b. Show how to perform PM jobs.
 - 15 c. Show Owner's personnel what to look for as indicators of equipment problems.
- 16 5. Corrective Maintenance:
 - 17 a. List possible problems.
 - 18 b. Discuss repairs – point out special problems.
 - 19 c. Open up equipment and demonstrate procedures, where practical.
- 20 6. Parts:
 - 21 a. Show how to use parts list and order parts.
 - 22 b. Check over spare parts on hand. Make recommendations.
- 23 7. Local Representatives:
 - 24 a. Where to Order Parts: name, address, and telephone.
 - 25 b. Service Problems:
 - 26 1) Who to call.

1 **SECTION 01 65 10**

2 **TESTING, TRAINING, AND COMMISSIONING**

3 **PART 1 – GENERAL**

4 **1.01 SUMMARY**

5 A. This section specifies the requirements for achieving, verifying, and documenting the
6 working condition of the facility, according to its planned function and operation, including
7 the training of operating personnel. This process includes, but is not limited to,
8 documentation and procedures, preinstallation and component testing, system and
9 operational testing, commissioning, and possession and use by the Owner. The process
10 is applicable to mechanical, electrical, and control systems and other completed portions
11 of the work, functioning as integrated systems of a completed operational facility.

12 B. Provide power, fuel, compressed air supplies, chemicals, calibrated testing equipment,
13 and all other necessary items and work required to complete the tests and inspections
14 specified herein, unless otherwise specified.

15 1. Provide temporary heating, ventilation, and air conditioning, as required for areas
16 within permanent facilities prior to commissioning.

17 2. If, under test, a portion of the work fails to meet the Contract requirements and is
18 adjusted, altered, renewed, or replaced, repeat tests on that portion, together with
19 other portions of the work affected, within a reasonable time and in accordance with
20 the specified conditions.

21 3. Test results to be within the tolerances set forth in the Specifications. If no tolerances
22 have been specified, conform to tolerances established by recognized industry
23 practice. Revise installation as necessary until tests are within tolerances.

24 4. Where, in the case of an otherwise satisfactory installed test, doubt or dispute arises
25 between the Owner representative and the Contractor regarding the test results or the
26 methods or equipment used in the performance of such test, then the Owner
27 representative may order the test to be repeated. The repeat test using such modified
28 methods or equipment will be paid per the following:

29 a. If the test results confirm the satisfactory installed test results, costs for the repeat
30 test will be paid by the Owner.

31 b. If the test results of an installed test fail to comply with the Contract requirements,
32 all costs associated with the repeat tests and equipment necessary to achieve the
33 Contract requirements are at the Contractor’s expense.

34 **1.02 QUALITY ASSURANCE**

35 A. Referenced Standards: This section incorporates by reference the latest revision of the
36 following documents. It is a part of this section as specified and modified. In case of conflict

1 between the requirements of this section and those of the listed documents, the
2 requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ASTM	American Society for Testing and Materials
HI	Hydraulic Institute Standards
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America

3 B. Install testing equipment and apparatus with personnel trained in the trades and
4 professions required to ensure competent workmanship.

5 C. Supervise the installation of specific equipment testing items specified to be accomplished
6 by factory-trained installation specialists furnished or certified by the
7 equipment manufacturers.

8 D. Document the skills and training of workers engaged in the installation of testing
9 equipment furnished by the Contractor.

10 **1.03 SUBMITTALS**

11 A. Procedures: Section 01 33 00, "Submittal Procedures."

12 B. Thirty Calendar Days After Notice to Proceed: A listing of all individual component and
13 system testing to be performed.

14 C. Test Plan Submittals:

15 1. Preinstallation test phase.

16 2. Component test phase.

17 3. System test phase.

18 4. Operational test phase.

19 5. Commissioning.

20 D. Testing Reports:

21 1. Test results demonstrating conformance to the contract requirements.

22 2. Documentation that test equipment was calibrated.

23 3. Documentation that test was witnessed by manufacturer's representative and Owner
24 representative, where required.

25 4. Certifications of installation and performance by manufacturer's representative,
26 where required.

27 E. Training Program:

28 1. Listing of all components and systems.

- 1 2. Training plans.
- 2 3. Documentation of training performed.

3 **1.04 TEST ENGINEER QUALIFICATIONS AND RESPONSIBILITIES**

4 A. Designate the Test Engineer.

5 1. The Test Engineer shall complete the following:

- 6 a. Review and approve all functional and performance tests, results, and
7 documentation for all components and systems.
- 8 b. Develop schedules for all testing, integrate testing into the master construction
9 activity schedule, and coordinate all required testing.
- 10 c. Coordinate testing with the Owner Representative and Owner Operations Staff.
- 11 d. Develop or assemble complete test program including schedule, procedures,
12 forms, and other documentation and submit for approval two months prior to
13 starting any field testing required.
- 14 e. Document the results of the testing.
- 15 f. Coordinate all cross-system testing.
- 16 g. Document any inconsistencies or deficiencies in system operations and ensure
17 system compliance.
- 18 h. Coordinate the required testing and approved procedures, including verification
19 that pretests have been satisfactorily conducted and the systems are ready for final
20 tests.
- 21 i. Obtain all documentation of component and systems' tests and assemble a final
22 test report.
- 23 j. Be available for participation in commissioning.

24 **1.05 DEFINITIONS**

- 25 A. Facility(ies): The sewage pump stations, including all associated structures, equipment,
26 and materials.
- 27 B. Equipment: All mechanical, electrical, instrumentation, controls, and other devices
28 specified in the Contract to provide a completed operational Facility.
- 29 C. System:
 - 30 1. A defined part of the Contract, consisting of an arrangement of items, such as
31 equipment, structures, piping, wiring, materials, or incidentals, so related or connected

- 1 to form an identifiable, unified, functional, operational, safe, and independent part of
2 the Contract.
- 3 2. Specific testing systems include, but are not limited to, the following:
- 4 a. Raw Sewage Pumping Systems:
- 5 1) Raw sewage pumps.
- 6 2) Force main flowmeters.
- 7 3) Wet well level controls.
- 8 4) PLC I/O and logic.
- 9 b. Stand-By Power System:
- 10 1) Control circuits, alarms and annunciators.
- 11 2) Monitoring components.
- 12 3) Manual transfer switch and connection for Tribe provided portable generator.
- 13 4) PLC I/O and logic.
- 14 c. Control circuits, alarms, and annunciators.
- 15 d. Other specified systems.
- 16 3. System Test Package: Comprehensive package of test procedures and results for
17 each system listed. Package shall include items listed in the paragraphs below.
18 Individual package shall be prepared for each system listed.
- 19 4. Preinstallation Test Phase:
- 20 a. Factory testing as specified in individual Specification Sections.
- 21 b. Standard factory tests of manufacturer and standard industry practice.
- 22 c. Delivery acceptance tests and inspections.
- 23 5. Component Test Phase: Installed component tests and inspections.
- 24 6. System Test Phase: Complete Systems tests and evaluations.
- 25 7. Operational Test Phase: Testing of the entire facility and interlocks. The full operation
26 of the facility for a specified period that ensures that all systems and processes operate
27 to defined design criteria.

1 **1.06 TESTING**

2 A. Specific testing is required at distinct stages of construction as follows:

3 1. Final Facilities Testing: Following the completion of each pump station, complete an
4 Operational Testing Phase on the entire Facility.

5 2. Prior to each phase of testing, submit the following per Section 01 33 00,
6 "Submittal Procedures."

7 a. Preinstallation Test Phase:

8 1) Results of factory tests specified in individual Specifications.

9 2) Other standard factory test results available from manufacturer.

10 b. Component Test Phase:

11 1) Written test procedures for Systems Test Package for each item of Equipment
12 for approval prior to testing.

13 2) Schedule indicating the order in which testing, training, operation, and
14 commissioning will occur.

15 3) Completed forms which include:

16 a) Verification of proper check-out, alignment, adjustment, and calibration.

17 b) All test information and results including specified operational parameters.

18 c) Use form for each item of equipment installed.

19 d) Use form which includes all test information including specified
20 operational parameters.

21 e) Separate sections to record values for preinstallation inspections and tests.

22 f) Initials of equipment manufacturer's representatives, the Contractor's
23 representative, and the Owner's Representative.

24 g) Record of relevant performance data for the original testing and not less
25 than three retests.

26 h) Format acceptable to the Owner's Representative.

27 c. System Test Phase:

28 1) System Test Package prior to testing a system. Include the following:

29 a) Identification of the system with a description of operating parameters.

- 1 b) Process and instrumentation diagrams detailing system.
- 2 c) Equipment list pertaining to the system with cross-references to the
3 appropriate Specifications. Reference Systems as defined above.
- 4 d) Written procedures detailing the Contractor's Component Tests and
5 System Tests proposed to verify equipment compliance with the
6 Specifications and operating parameters.
- 7 e) Submittals from Preinstallation Test Phase and delivery acceptance tests
8 and inspections for each Component Test of the System.
- 9 f) Submittals from Component Tests Phase for each component of the
10 system.
- 11 2) Update System Test Package with results of System Test phase.
- 12 3) Submit Complete System Test results and evaluations.
- 13 d. Testing Stage Submittals:
- 14 1) General:
- 15 a) Complete description and schedule of all testing to be completed at each
16 test stage and submit a minimum of two months prior to initiating test stage.
- 17 b) Following completion of System testing, submit Testing Results Transmittal
18 form from Section 01 99 99.

19 **1.07 TRAINING**

- 20 A. Procedure: Section 01 33 00, "Submittal Procedures."
- 21 1. Master Training Schedule for Operations and Maintenance:
- 22 a. Submit 30 days prior to start of system test phase for first training presentation.
- 23 b. Schedule to include:
- 24 1) Target date and time for each operating and maintenance training presentation
25 for each system, both field and classroom.
- 26 2) Target date for initiation of Commissioning period.
- 27 3) Do not schedule training on weekends or holidays observed by the Owner.
- 28 4) Coordinate training scheduling with applicable Owner staff work schedule.
- 29 2. After each training, submit information related to training, including but not limited to
30 the date and time, the location of the training, the specific piece of equipment, the
31 person(s) performing the training and their contact information, the person(s) present

1 receiving the training, any handout and notes, and any material covered during the
2 training.

3 **PART 2 – PRODUCTS (NOT USED)**

4 **PART 3 – EXECUTION**

5 **3.01 MATERIALS AND EQUIPMENT**

6 A. Comply with the requirements of this Contract and the recommendations of the
7 equipment manufacturers.

8 B. Provide test gauges, meters, recorders and monitors as required to supplement or
9 augment the instrumentation system provided under this Contract to properly demonstrate
10 that equipment fully satisfies the specified requirements. Specifically select devices
11 employed for the purpose of measuring the performance of the facility's equipment and
12 systems to be consistent with the variables to be monitored. Instruments are to be
13 recently calibrated.

14 C. Demonstrate through recalibration the accuracy of instruments employed for
15 testing purposes.

16 D. Calibration procedures are in accordance with applicable standards of ASTM, ISA, and
17 IEEE to ensure the adequacy and calibration of gauges, meters, recorders, and monitors.

18 **3.02 INSTALLATION**

19 A. Install equipment in accordance with the details shown and specified in full compliance
20 with manufacturer's requirements. Notify the Owner's Representative of conflict between
21 a manufacturer's installation recommendations and specific requirements of the
22 Contract Documents.

23 **3.03 TESTING**

24 A. General Requirements:

25 1. Test and inspect equipment and partially completed or fully completed portions of the
26 work to prove compliance with the Contract requirements.

27 2. Unless otherwise noted, pay all costs of testing, including temporary facilities
28 and connections.

29 3. Test the following:

30 a. Equipment with one or more moving parts or devices requiring an electrical,
31 pneumatic, or hydraulic connection.

32 b. Leakage tests and other piping tests.

33 c. Electrical devices and systems.

- 1 d. Instrumentation devices and systems.
- 2 e. Receive Owner Representative's approval for the application of all tests only after
3 Owner Representative's inspection of equipment for conformance with
4 the Specifications.
- 5 f. Tests and inspections, unless otherwise specified or accepted, are in accordance
6 with the recognized standards of the industry. Allow for up to two additional set
7 point changes during testing.
- 8 4. Procedures:
- 9 a. Design testing procedures to duplicate, as nearly as possible, conditions of
10 operation to ensure that the equipment is not damaged. Once the testing
11 procedures have been reviewed and approved by the Owner Representative,
12 organize by system into test packages, and include the proper checkout,
13 alignment, adjustment, and calibration signoff forms for each item of equipment
14 and system.
- 15 b. Jointly use forms with the Owner Representative to ensure that documentation for
16 each electrical, mechanical, and instrumentation equipment item has been
17 properly recorded for installation and testing. Failure to follow the Owner's
18 Representative approved procedure will result in nonacceptance of the equipment.
- 19 c. Fulfillment of the test and inspection requirements are by either of the following:
- 20 1) Tests and inspections carried out in Owner Representative's presence, or;
- 21 2) Certificates or reports of tests and inspections carried out by Owner
22 Representative approved persons or organizations.
- 23 d. Maintain the systems test packages, which contain tests and sign-off forms
24 including, but not limited to, piping, equipment, electrical, and instrumentation.
25 Submit test packages to the Owner for inspection upon request.
- 26 5. Phases:
- 27 a. Preinstallation Test Phase:
- 28 1) Test items at the place of manufacture during or on completion of manufacture.
29 Tests include, but are not limited to hydraulic pressure tests, electric and
30 instrumentation subsystem tests, performance, and operating tests
31 and inspections.
- 32 2) Perform in accordance with the relevant standards of the industry if not
33 specified in the Contract Documents. Tests other than those specified are in
34 accordance with the Special Provisions.
- 35 3) When items are delivered to the site, remove all coverings, containers, or
36 crates in order to permit the Owner Representative to conduct the inspection
37 to determine if the items are of the specified quality and workmanship, and are
38 visually in good order and condition at the time of delivery. Should the Owner

1 Representative find, in its opinion, indication of damage or deficient quality of
2 workmanship, provide the necessary documentation or conduct such tests to
3 demonstrate compliance.

4 b. Component Test Phase:

5 1) General:

6 a) Identify component equipment in each system to be tested to the specified
7 requirements, in testing procedure submittals, prior to component testing
8 and before a system is placed into operation.

9 b) Incorporate requirements of the Specifications into the installed tests and
10 inspection procedures and proceed in a logical, step-wise sequence to
11 ensure that the installed equipment has been properly assembled,
12 serviced, aligned, adjusted, connected, and calibrated prior to operation.

13 c) Perform all changes, adjustments, or replacements required to make the
14 equipment operate.

15 2) Component testing procedures include, but are not limited to:

16 a) Piping system pressure testing and cleaning.

17 b) Equipment testing.

18 c) Electrical system testing.

19 d) Instrumentation system testing:

20 e) Provide and complete a checklist to verify discrete and analog inputs from
21 field devices update PLC memory registers.

22 f) Provide and complete a checklist to verify PLC discrete and analog outputs
23 are connected to field devices.

24 g) Testing, checking, and correcting deficiencies of:

25 i) Power, control, and monitoring circuits for continuity prior to
26 connection to power source.

27 ii) Voltage of all circuits.

28 iii) Phase sequence.

29 iv) Cleanliness of connecting piping systems.

30 v) Alignment of connected machinery.

31 vi) Vacuum and pressure of all closed systems.

- 1 vii) Lubrication.
- 2 viii) Valve orientation and position status for manual operating mode.
- 3 ix) Instrumentation and control signal generation, transmission,
4 reception, and response.
- 5 x) Tagging and identification systems.
- 6 xi) Proper connections, alignment, calibration, and adjustment.
- 7 h) Calibrate all safety equipment.
- 8 i) Manually rotate or move moving parts to ensure freedom of movement.
- 9 j) Bump electric motors to verify power and direction of rotation.
- 10 k) Perform other tests, checks, and activities required to make component
11 ready for System Test Phase.
- 12 3) Obtain approval of operation and maintenance information as specified prior to
13 testing.
- 14 c. System Test Phase:
- 15 1) General:
- 16 a) Once the Owner Representative has approved equipment required for the
17 Component Test Phase and has not found deficiencies in that portion of the
18 work, test and operate all individual systems under operating conditions to
19 determine as comprehensively as possible whether the equipment and
20 system meet the requirements of the Specifications. See specific system
21 testing procedures below.
- 22 b) Except as described below, employ potable water in the testing of all liquid
23 systems. For all other systems use the intended fluid or a compatible
24 substitute. Owner Representative to approve test media disposal methods.
- 25 c) When testing requires the use of auxiliary systems such as electrical power,
26 compressed air, control air, or instrumentation which have not yet been
27 placed in service, provide acceptable substitute sources, capable of
28 meeting the requirements of the machine, device or system.
- 29 d) Maintain temporary facilities until permanent services are in service.

- 1 e) Following System Testing:
- 2 i) Recheck machines for proper alignment; realign if necessary and
- 3 dowel in place.
- 4 ii) Check equipment for loose connections, unusual movement, or other
- 5 indications of improper operating characteristics.
- 6 iii) Correct deficiencies to the requirements of the Owner's
- 7 Representative.
- 8 iv) Disassemble and inspect equipment which exhibits unusual or
- 9 unacceptable operating characteristics. Repair or remove from the
- 10 site and replace with new. Test until the equipment meets the
- 11 requirements of the Specifications.
- 12 2) Field Testing to Verify Performance Requirements:
- 13 a) As part of system test phase, completely field test each equipment item
- 14 over the entire range of operating conditions.
- 15 b) Record flow, suction pressure, and discharge pressure in field
- 16 testing report.
- 17 c) Perform vibration tests where specified in individual equipment
- 18 specification. Vibration tests shall be in accordance with
- 19 Hydraulic Institute Standards.
- 20 d) Provide necessary pressure and flow measuring equipment. Calibrate prior
- 21 to use.
- 22 e) Provide a complete field testing report on each equipment item and include
- 23 in system Test Package.
- 24 3) System test procedures include, but are not limited to:
- 25 a) Provide and complete a checklist to demonstrate discrete and analog
- 26 points are displayed on Forney graphic screens at main control.
- 27 b) Provide and complete a checklist to demonstrate discrete and analog
- 28 points are displayed on Metrotel graphic screen at main control.
- 29 c) Provide and complete a checklist to demonstrate operator entries via
- 30 Forney interface are communicated to PLC memory.
- 31 d) Provide and complete a checklist to demonstrate entries via the
- 32 SCADA signals.
- 33 e) Provide and complete a checklist to verify discrete and analog inputs from
- 34 field devices update PLC operator interface panel.

- 1 f) Provide and complete a checklist to demonstrate operator entries via PLC
2 interface panel control.
- 3 g) Actuate all alarms from field devices by physically changing state of field
4 device to cause alarm. Do not simulate conditions. Provide and complete
5 a checklist to demonstrate that all alarms are received on annunciators,
6 PLC interface, and Forney displays.
- 7 h) Test systems to the Owner's Representative requirements prior to
8 proceeding to Operational Test Phase.
- 9 4) The following procedures are in addition to and supplement those procedures
10 described above. Additional specific system test procedures include, but are
11 not limited to, the following:
- 12 a) Pump Station Wet Well Level Monitoring Systems:
- 13 i) Simulate 25%, 50%, and 100% of span on level systems. Verify that
14 level data is transferred to the facility PLC.
- 15 ii) Simulate the pressure switch trip points. Verify that the level switches
16 switch at the proper point and that the data is transferred to the
17 facility PLC.
- 18 iii) Verify that all float switch contacts are opening and closing by lifting
19 and lowering each individual float.
- 20 b) Raw Sewage Pumping System: Initiate flow of sewage to the pump inlet in
21 the wet well. With the pump in hand mode allow the level to rise in the
22 pumping station wet well. Demonstrate and test all automatic and manual
23 functions of the pumping system.
- 24 c) Standby Power System:
- 25 i) Demonstrate the function of the engine generator and transfer switch
26 by opening the main breaker to the pumping station.
- 27 ii) Simulate a low battery voltage condition and verify alarm is
28 transmitted to the control panel and PLC.
- 29 iii) Simulate high and low fuel tank level and verify alarm is transmitted to
30 the control panel and PLC.
- 31 d) Fire Alarm and Intrusion Monitor Systems: If applicable, demonstrate
32 complete operation of systems and verify all alarms and controls.
- 33 5) Complete Manufacturer's Certificate of Proper Installation Form in
34 Section 01 99 99, "Forms" following all testing.

- 1 6. Operational Test Phase:
- 2 a. General:
- 3 1) After completion of the System Test Phase and approval by the Owner
4 Representative that systems and equipment comply with the requirements of
5 the Specifications, configure all systems for complete automatic operation
6 as required.
- 7 2) Provide a continuous 48-hour facility automatic operation performance test
8 prior to Commissioning.
- 9 3) Provide 1-week notice to Owner Representative prior to starting Operational
10 Test in order that Owner staff may be coordinated to provide support
11 as needed.
- 12 4) Coordinate to ensure the Owner's operation is not compromised.
- 13 5) Coordinate and schedule sewage flows prior to starting Operational Test.
- 14 6) Do not allow overflows.
- 15 7) Repeat the operational testing until the specified operating modes have been
16 accomplished without interruption. Should the operational test mode be halted
17 for any reason related to the facilities or the equipment constructed under this
18 Contract, or the Contractor's temporary testing of systems, the operational
19 testing mode shall be repeated until it has been accomplished
20 without interruption.
- 21 a) Bring process units to full operating conditions, including temperature,
22 pressure, and flow.
- 23 b) Test in a step-by-step method, in accordance with the Contractor's
24 approved written testing procedures. Accomplish the testing work in an
25 orderly, systematic testing of equipment, systems, structures, and the
26 complete Facility as a unit. Owner Representative to witness each
27 individual step in the procedures.
- 28 c) Operate Equipment and Systems during the operational testing phase, to
29 the greatest extent practical, at conditions which represent the full range of
30 operating parameters as defined in the Contract Documents.
- 31 d) Unless otherwise noted, the facility shall perform through its complete
32 design range for a period of two consecutive 24-hour days.
- 33 e) Potable water, fuel, power, and chemicals required during the operational
34 test phase shall be provided by the Contractor.
- 35 f) Supply operational manpower for testing requiring 24-hour operations.

1 g) Submit operations phase test results in three compiled volumes (original
2 and two copies) within 5 days of completion of this testing phase.

3 b. Procedures:

4 a) Completed Facility Initial Operation Mode:

5 b) After modifications to each pump replacement, initiate flow through the
6 pump from the wet well.

7 c) Operate the pump in hand mode and allow the level in the wet well to rise.

8 d) Demonstrate complete automatic operation of the facility for all
9 pump operations.

10 7. Contractor's Responsibilities:

11 a. Be responsible for necessary repairs and replacements required to maintain the
12 operational.

13 b. Be available to provide immediate response 24 hours per day, 7 days a week, in
14 case of failure of any portion.

15 8. Owner's Responsibilities: Normal operational cost including, but not limited to,
16 electricity.

17 **3.04 COMMISSIONING**

18 A. After completion of the Operational Test Phase and certification by the Owner
19 Representative that System and Operational tests meet performance requirements, that
20 the required training is complete and that all required documents are submitted, the Owner
21 will begin operating the facility during the Commissioning Period.

22 B. Prior to start of Commissioning, remove temporary piping, plugs and other apparatus that
23 may have been in use during the operational tests.

24 C. Provide required labor to support the Owner to ensure the facility attains its fully
25 operational mode.

26 D. The Owner's operations personnel will be responsible for operation of the facility or portion
27 thereof during commissioning. The facility shall be fully operational, capable of accepting
28 design flows, and performing functions as designed.

29 E. The Owner is responsible for costs of normal operation including, but not limited to
30 supplies, electricity, and chemicals.

31 F. Be responsible for all costs of necessary maintenance, repairs, or replacements required
32 to keep the facility operational during the commissioning period. Failures of equipment will
33 require restart of Commissioning Period.

- 1 G. Be available to provide immediate assistance 24 hours per day, seven days per week, in
2 case of failure of a portion of the system being operated. Provide a 24-hour phone contact.
- 3 H. The Commissioning Period is successfully completed upon 5 continuous days' operation
4 without equipment failures, and in accordance with the contract required performance, for
5 all systems being commissioned.

6 **3.05 TRAINING**

- 7 A. Conduct all personnel training after completion of Component Test Phase for the
8 equipment for which training is being conducted, but no later than 5 working days after
9 System Test Phase begins:
- 10 1. Personnel training on individual Equipment or System will not be considered
11 completed unless:
- 12 a. All training deliverables are received and approved before commencement of
13 training on the individual equipment or system.
- 14 b. No system malfunctions occur during training.
- 15 c. All provisions of field and classroom training are met.
- 16 d. Training not in compliance with the above shall be performed again in its entirety
17 by the Contractor.
- 18 2. Field and Classroom Training Requirements:
- 19 a. Hold classroom training at Owner-designated facility.
- 20 b. Training Days: Monday, Tuesday, Wednesday, Thursday, and Friday.
- 21 c. Training Instructor: Factory trained and familiar with giving both classroom and
22 hands-on instructions.
- 23 d. Training Instructors: Be at class on time. Session beginning and ending times to
24 be coordinated with the Owner Representative and indicated on the master
25 schedule. Normal time lengths for class periods can vary, but brief rest breaks shall
26 be scheduled and taken.
- 27 e. Organize training into separate maintenance and operation sessions and identify
28 on schedule.
- 29 f. Plan for maximum class attendance of 12 people at each session and provide
30 sufficient classroom materials, samples, and handouts for those in attendance.
- 31 g. Instructors to have a typed agenda and well prepared instruction material. The use
32 of visual aids, e.g. films, pictures, and slides is recommended for use during the
33 classroom training programs.
- 34 h. Provide equipment required for presentation of films, slides, and other visual aids.

- 1 i. Maintain a log of classroom training including: instructors, topics, dates, time,
2 and attendance.
- 3 3. Make available experienced factory-trained representatives of the manufacturers of
4 the various pieces of equipment to train the Owner's personnel in the operation and
5 maintenance thereof. The time required for this training is as specified for each piece
6 of equipment and as specified in this section.
- 7 4. Notify the Owner Representative of the time of the training at least 10 days prior to the
8 day of the training.
- 9 5. The training requirements are shown in individual Specification Sections. It is the
10 Contractor's responsibility to coordinate those requirements.

11 **3.06 TRAINING PRESENTATION CONTENTS**

- 12 A. Train the Owner's personnel only with manufacturers' representatives. Provide correct
13 expertise during any questioning periods. Use the following general outline for
14 manufacturer training presentations:
 - 15 1. Familiarization:
 - 16 a. Show catalog, parts lists, drawings, and O&M manuals.
 - 17 b. Provide overview of design intent.
 - 18 c. Review the installation of the specific equipment items.
 - 19 d. Demonstrate the unit's operation.
 - 20 e. Answer questions.
 - 21 2. Safety:
 - 22 a. Point out safety references.
 - 23 b. Discuss safety precautions around equipment.
 - 24 3. Operation:
 - 25 a. Point out reference literature.
 - 26 b. Explain all modes of operation, including emergency.
 - 27 c. Test personnel on proper use of the equipment by letting them operate it.
 - 28 4. Preventative Maintenance (PM):
 - 29 a. Pass out the PM list, including reference material, and daily, monthly, quarterly,
30 semiannual, and annual PM tasks.

- 1 b. Demonstrate how to perform PM tasks.
- 2 c. Identify indicators of equipment problems.
- 3 5. Corrective Maintenance:
- 4 a. List possible problems.
- 5 b. Discuss repairs; point out special problems.
- 6 c. Open up the Equipment and demonstrate procedures where practical.
- 7 6. Parts:
- 8 a. Review spare parts list, and provide storage and storage maintenance instruction.
- 9 b. Indicate how to order additional spare parts.
- 10 c. Provide recommendations for spare parts inventory.
- 11 B. Schedule and attend a planning and coordination meeting 10 days prior to first anticipated
- 12 training presentation.
- 13 C. Provide a status report and schedule-to-complete for requirements prerequisite to
- 14 training presentation.
- 15 D. Provide agenda for each training presentation a minimum of 7 days prior to the
- 16 training presentation.
- 17 E. Document staff which received training.
- 18 F. The Owner may elect to video record the training sessions given by the manufacturer's
- 19 representative of ongoing Owner staff training; provide accommodation for
- 20 video recording.

21 **3.07 PAYMENT**

- 22 A. Payment for the work specified in this section shall be incidental to the project.

23 **END OF SECTION**

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1 **SECTION 01 77 00**

2 **CLOSEOUT PROCEDURES**

3 **PART 1 – GENERAL**

4 **1.01 SUBSTANTIAL COMPLETION**

- 5 A. Contractor shall complete all the work within the time designated in the Agreement unless
6 modified by Change Order or the Certificate of Substantial Completion.
- 7 B. Should the Owner or Engineer consider that work is not Substantially Complete:
- 8 1. Engineer shall notify the Contractor in writing stating reasons thereof.
- 9 2. Contractor shall complete work and send subsequent written notice(s) to Owner and
10 Engineer certifying that work or designated portion of work is Substantially Complete.
- 11 C. Contractor shall submit all warranty certificates at the time of application for Substantial
12 Completion. The guarantee and warranty periods begin with the date of Final Acceptance.
13 However, in connection with any specific equipment certified by the Owner as completed
14 and its use or operation thereof for its intended purpose is assumed by the Owner, the
15 warranty period for such equipment shall begin with the beginning date of such use or
16 operation.

17 **1.02 FINAL CLEANING**

- 18 A. Final Cleaning of Structures:
- 19 1. In preparation for Substantial Completion or occupancy, conduct final inspection of
20 sight-exposed interior and exterior surfaces, and of concealed spaces.
- 21 2. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials, from
22 sight-exposed interior and exterior finished surfaces; polish surfaces so designated to
23 shine finish.
- 24 3. Repair, patch, and touch up marred surfaces to specified finish, to match
25 adjacent surfaces.
- 26 4. Broom clean paved surfaces; rake clean other surfaces of grounds.
- 27 5. Maintain cleaning until work is complete.
- 28 B. Final Cleanup of Pipelines:
- 29 1. Final cleanup work shall be completed as closely behind the work as it is physically
30 possible to do.

1 2. Unless otherwise specifically provided in writing only those portions of the completed
2 work will be included in the partial pay estimates where, in the Owner's or Engineer's
3 opinion, the cleanup work has been satisfactorily completed.

4 3. Refer to specific sections for detailed requirements for cleanup of pipelines.

5 C. General Cleanup:

6 1. Before Final Acceptance, the Contractor shall remove and obliterate, insofar as
7 feasible, all objects or disturbances of the ground that mar the landscape and were
8 caused by his operations, whether or not part of the improvement.

9 2. Rubbish, excess materials, temporary structures, and discarded equipment shall be
10 removed and disposed of daily.

11 3. Fill holes and grade to smooth land contours. Shape ends of cuts and fills to fit
12 adjacent terrain.

13 4. Hand rake disturbed areas to remove loose objects including rock and clods in excess
14 of 2 inches in any dimension.

15 5. Sweep pavement, curb and gutter, sidewalks and driveways.

16 **1.03 FINAL INSPECTION**

17 A. Final inspection shall be conducted in accordance with the Contract.

18 **1.04 FINAL PAYMENT**

19 A. Submit final pay request to Owner in accordance with the Contract.

20 **PART 2 – PRODUCTS (NOT USED)**

21 **PART 3 – EXECUTION (NOT USED)**

22 **END OF SECTION**

- 1 7. Cover: Identify each volume with typed or printed title "OPERATION AND
2 MAINTENANCE MANUAL, VOLUME NO. ____ OF ____", if applicable, and list:
- 3 a. Project title.
- 4 b. Designate the system or equipment for which it is intended.
- 5 c. Identity of separate structure as applicable.
- 6 d. Identity of general subject matter covered in manual. Identity of equipment number
7 and specification section.
- 8 8. Assemble and bind material in same order as specified, as much as possible.
- 9 9. Material shall be suitable for reproduction, with quality equal to original. Photocopying
10 of material will be acceptable, except for material containing photographs or
11 detailed graphics.
- 12 10. Binders:
- 13 a. Preliminary Manuals: Electronic searchable PDF files.
- 14 b. Final Manuals: Commercial quality, substantial, permanent, three-ring locking slant
15 "D" style binders with durable, cleanable, plastic covers.
- 16 11. Table of contents neatly typewritten, arranged in a systematic order:
- 17 a. Contractor, name of responsible principal, address, and telephone number.
- 18 b. List of each product required to be included, indexed to content of each volume.
- 19 c. List with each product the name, address, and telephone number of subcontractor,
20 supplier, installer, and maintenance contractor, as appropriate:
- 21 1) Identify area of responsibility of each.
- 22 2) Provide local source of supply for parts and replacement.
- 23 d. Identify each product by product name and other identifying numbers or symbols
24 as set forth in Contract Documents.
- 25 12. Product Data:
- 26 a. Include only those sheets that are pertinent to specific product.
- 27 b. Clearly annotate each sheet to:
- 28 1) Identify specific product or part installed.
- 29 2) Identify data applicable to installation.
- 30 3) Delete references to inapplicable information.

- 1 13. Drawings:
- 2 a. Supplement product data with drawings as necessary to clearly illustrate:
- 3 1) Relations of component parts of equipment and systems.
- 4 2) Control and flow diagrams.
- 5 3) Coordinate drawings with project record documents to ensure correct
- 6 illustration of completed installation.
- 7 4) Do not use project record documents as maintenance manual drawings.
- 8 5) Provide reinforced three-hole punched binder envelope, bind in with text.
- 9 6) Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2
- 10 inches by 11 inches.
- 11 7) Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch
- 12 envelopes bound in text.
- 13 8) Identify specification section and product on drawings and envelopes.
- 14 14. Instructions and Procedures: Within text as required to supplement product data.
- 15 a. Handling, storage, maintenance during storage, assembly, erection, installation,
- 16 adjusting, testing, operating, shutdown in emergency, troubleshooting,
- 17 maintenance, interface, and as may otherwise be required.
- 18 b. Organize in a consistent format under separate heading for each
- 19 different procedure.
- 20 c. Provide a logical sequence of instructions for each procedure.
- 21 d. Provide information sheet for Owner's personnel, including:
- 22 1) Proper procedures in the event of failure.
- 23 2) Instances that might affect the validity of warranties or bonds.

24 **1.04 SUBMITTALS**

- 25 A. Preliminary Manuals:
- 26 1. Submit electronic searchable copy (PDF format) for Engineer's review.
- 27 2. Disposition and Distribution: In accordance with Section 01 33 00, "Submittal
- 28 Procedures."
- 29 3. Engineer's review will be based on the Operations and Maintenance Review Checklist
- 30 form in Section 01 99 99, "Forms."

1 B. Final Manuals: Submit four bound, hard paper copies and one searchable electronic copy
2 (PDF format) of the Final Manual.

3 **1.05 MANUALS FOR EQUIPMENT AND SYSTEMS**

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

5 1. Description of unit and component parts including controls, accessories,
6 and appurtenances:

7 a. Function, normal operating characteristics, and limiting conditions.

8 b. Performance curves, engineering data, nameplate data, and factory and field tests.

9 c. Complete nomenclature and commercial number of replaceable parts.

10 2. Operating Procedures:

11 a. Start-up, break-in, routine, and normal operating instructions.

12 b. Test procedures and results of factory tests where required.

13 c. Regulation, control, stopping, and emergency instructions.

14 d. Description of operation sequence by control manufacturer.

15 e. Shutdown instructions for both short and extended durations.

16 f. Summer and winter operating instructions, as applicable.

17 g. Safety precautions.

18 h. Special operating instructions.

19 i. Installation instructions.

20 3. Maintenance and Overhaul Procedures:

21 a. Routine operations.

22 b. Guide to troubleshooting.

23 c. Disassembly, removal, repair, reinstallation, and reassembly.

24 4. Installation Instructions: Including alignment, adjusting, calibrating, and checking.

25 5. Original manufacturer's parts list, illustrations, detailed assembly drawings showing
26 each part with part numbers and sequentially numbered parts list, and diagrams
27 required for maintenance.

28 6. Maintenance Summary Form in Section 01 99 99, "Forms."

- 1 7. Spare parts ordering instructions and list of recommended spare parts.
- 2 8. Where applicable, identify installed spares and other provisions for future work (e.g.,
- 3 reserved panel space, unused components, wiring, terminals).
- 4 9. Manufacturer's printed operating and maintenance instructions.
- 5 10. As-installed, color-coded piping diagrams.
- 6 11. Charts of valve tag numbers, with location and function of each valve.
- 7 12. Description of Warranty.
- 8 B. Content for Each Electric or Electronic Item or System:
- 9 1. Description of Unit and Component Parts:
- 10 a. Function, normal operating characteristics, and limiting conditions.
- 11 b. Performance curves, engineering data, nameplate data, and tests.
- 12 c. Complete nomenclature and commercial number of replaceable parts.
- 13 d. Interconnection wiring diagrams, including all control and lighting systems.
- 14 2. Circuit Directories of Panelboards:
- 15 a. Electrical service.
- 16 b. Controls.
- 17 c. Communications.
- 18 3. List of electrical relay settings, and control and alarm contact settings.
- 19 4. Electrical interconnection wiring diagram, including control and lighting systems.
- 20 5. As-installed control diagrams by control manufacturer.
- 21 6. Operating Procedures:
- 22 a. Routine and normal operating instructions.
- 23 b. Sequences required.
- 24 c. Safety precautions.
- 25 d. Special operating instructions.

- 1 7. Maintenance Procedures.
 - 2 a. Routine operations.
 - 3 b. Guide to troubleshooting.
 - 4 c. Adjustment and checking.
 - 5 d. List of relay settings, control and alarm contact settings.
- 6 8. Manufacturer's printed operating and maintenance instructions.
- 7 9. List of original manufacturer's spare parts, manufacturer's current prices, and
 - 8 recommended quantities to be maintained in storage.
- 9 C. Detailed Master List:
 - 10 1. Provide a detailed master list as a separate section within the operating and
 - 11 maintenance manual.
 - 12 2. Subdivide sections into the following categories:
 - 13 a. Equipment with spare parts list with current prices.
 - 14 b. Recommended equipment expendables to be on hand.
 - 15 c. Recommended test equipment.
 - 16 d. Miscellaneous loose items which have relevant importance.
- 17 D. Software Manuals: Provide hard copies and electronic copies of all software manuals and
 - 18 program listings associated with equipment to be provided in the process instrumentation
 - 19 and control system.

20 **PART 2 – PRODUCTS (NOT USED)**

21 **PART 3 – EXECUTION (NOT USED)**

22 **END OF SECTION**

1 **SECTION 01 99 99**

2 **FORMS**

3 **PART 1 – GENERAL**

4 **1.01 FORMAT**

5 A. Electronic Versions: Engineer will provide, upon request, all forms in Microsoft Word
6 format for Contractor’s use on this Project.

7 B. Forms with project specific information will be issued to Contractor at Preconstruction
8 Conference.

9 **1.02 FORMS**

10 A. Submittal Transmittal.

11 B. Manufacturer’s Certificate of Proper Installation.

12 C. Operation and Maintenance Manual Review Checklist.

13 D. Maintenance Summary.

14 E. Motor Data.

15 F. Warranty Documentation Form.

16 G. Release and Certificate of Payment.

17 H. Testing Results Transmittal.

18 **PART 2 – PRODUCTS (NOT USED)**

19 **PART 3 – EXECUTION (NOT USED)**

20 **(FORMS FOLLOW)**

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Submittal Transmittal

Transmittal No.: _____

To: _____

ATTN: _____ Date: _____
Project: _____ Project No.: _____
Owner: _____ Location: _____
Previous Transmittal No. (if resubmitted): _____

USE ONE FORM PER ITEM SUBMITTED

Qty.	Spec. Para. No.	Spec. Page No.	Item Description and Use	Manufacturer	Dwg. No(s).	Approval Status (Engineer)

By this submittal, the Contractor represents that he has determined and verified all field measurements, field construction criteria, materials, catalog numbers and similar data, or will do so, and that he has checked and coordinated each Shop Drawing with the project requirements and of the Contract Documents. Deviations from the Contract Documents are noted below.

Deviations: _____

Contractor: _____ Signature: _____

(THIS SPACE FOR Engineer)

To: _____ Date: _____

Enclosed are _____ copies of the above item. Approval status as noted above is in accordance with the following legend:

- A. No Exceptions Taken
- B. Make Corrections Noted
- C. Rejected
- D. Revise and Resubmit
- E. Submit Specified Item
- F. _____

See attached Comment Sheet Dated _____

Checking is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action shown is subject to the requirements of the Plans and specifications. Contractor is responsible for: dimensions which shall be confirmed and correlated at the job site; fabrication processes and techniques of construction, coordination of his work with that of all other trades and the satisfactory performance of his work.

By: _____

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Manufacturer's Certificate of Proper Installation

Contract No.: _____ Specification Section: _____

Contractor: _____

Equipment Name: _____ Equipment No.: _____

Manufacturer: _____

The undersigned manufacturer of the equipment item described above hereby certifies that he has checked the installation of the equipment and that the equipment, as specified in the project manual, has been provided in accordance with the manufacturer's recommendations and that the trial operation of the equipment item has been satisfactory.

Comments: _____

Date Manufacturer

Date Signature of Authorized Representative

Date Contractor

Date Signature of Authorized Representative

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Operation and Maintenance Manual Review Checklist

Equipment: _____

Submittal No.: _____

Specification
Section: _____

MANUAL FORMAT *

- | | |
|--|---|
| <input type="checkbox"/> Three Ring Binder, Plastic Covers (final) | <input type="checkbox"/> System/Equipment Title |
| <input type="checkbox"/> Heavy Paper Covers (preliminary) | <input type="checkbox"/> Contractor Name, Address, Phone Number |
| <input type="checkbox"/> 8-1/2" x 11", Folded 11" x 17" | <input type="checkbox"/> Title Page |
| <input type="checkbox"/> No Odd Size Envelopes | <input type="checkbox"/> Table of Contents |
| <input type="checkbox"/> White Paper (20-lb) | <input type="checkbox"/> Volume X of Y |
| <input type="checkbox"/> Printed or Typewritten | <input type="checkbox"/> Section Dividers with Numbered Plastic Reinforced Index Tabs |
| <input type="checkbox"/> Hole Punched | <input type="checkbox"/> Sections Ordered Same as Specification |
| <input type="checkbox"/> Project Title | |

* Also provide electronic searchable PDF.

MANUAL CONTENT

- | | |
|--|---|
| <input type="checkbox"/> Each Item of Equipment/System | <u>Instructions:</u> |
| <input type="checkbox"/> Equipment/System Description | <input type="checkbox"/> Handling |
| <input type="checkbox"/> Controls Description | <input type="checkbox"/> Storage |
| <input type="checkbox"/> Curves, Data | <input type="checkbox"/> Installation |
| <input type="checkbox"/> Parts List, Assembly Drawings, Part Numbers | <input type="checkbox"/> Testing |
| <input type="checkbox"/> Drawings (spatial/mechanical/assembly) | <input type="checkbox"/> Operating |
| <input type="checkbox"/> Spec Section and Product Name on Drawings/Envelopes | <input type="checkbox"/> Maintenance |
| <input type="checkbox"/> Diagrams (control/flow) | <input type="checkbox"/> Shutdown |
| <input type="checkbox"/> Safety Information | <u>Maintenance Summary Forms:</u> |
| <input type="checkbox"/> Troubleshooting Guide | <input type="checkbox"/> Correct Form Used |
| <input type="checkbox"/> Inapplicable Data (crossed out or deleted) | <input type="checkbox"/> 8-1/2" x 11" |
| <input type="checkbox"/> Spare Parts Ordering Instructions | <input type="checkbox"/> Typewritten |
| <input type="checkbox"/> Copies of Warranties, Bonds, Service Agreements | <input type="checkbox"/> Form Completely Filled Out |
| <input type="checkbox"/> Factory Test Results | <input type="checkbox"/> Form for Each Unit |
| | <input type="checkbox"/> Lubrication Instructions |
| | <input type="checkbox"/> Recommended Spare Parts |

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Maintenance Summary

PROJECT: _____ CONTRACT NO.: _____

1. Equipment Item: _____

2. Manufacturer: _____

3. Equipment/Tag No.(s): _____

4. Weight of Individual Components
(Over 100 Pounds): _____

5. Nameplate Data
(hp, voltage, speed, etc.): _____

6. Manufacturer's Local Representative:

a. Name: _____ Telephone No.: _____

b. Address: _____

7. Maintenance Requirements:

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

Maintenance Summary

8. Lubricant List:

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

9. Recommended Spare Parts for Owner's Inventory:

<u>Part No.</u>	<u>Description</u>	<u>Unit</u>	<u>Quantity</u>	<u>Unit Cost</u>

Motor Data

Equipment Name: _____ Equipment No.: _____

Site Location: _____

Nameplate Markings:

Mfr: _____ Mfr Model: _____ Frame: _____ HP: _____

Volts: _____ Phase: _____ RPM: _____ Service Factor: _____

FLA: _____ LRA: _____ Frequency: _____ Ambient Temp Rating: _____ Degrees C

Time Rating: _____ Design Letter: _____
(NEMA MG1-10.35) (NEMA MG-1.16)

KVA Code Letter: _____ Insulation Class: _____

The following information is required for explosion-proof motors only:

- A. Approved by UL for installation in Class _____, Division _____.
- B. UL frame temperature code _____; Group _____ Atmosphere (NEC Tables 500-s and 500-s(b)).

The following information is required for high efficiency motors only:

- A. Guaranteed minimum efficiency at full load or NEMA efficiency index:

(NEMA MG1-12.53b)

- Nameplate or nominal efficiency: _____

Data Not Necessarily Marked on Nameplate:

Type of Enclosure: _____ Enclosure Material: _____

Temp Rise: _____ Degrees C (NEMA MG1-12.41,42)

Space heater included? Yes No

If Yes, Watts: _____ Volts: _____

Type of rotor winding over-temperature protection, if specified:

Use the space below to provide additional information on other motor modifications, if specified:

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Release and Certificate of Payment

1. Date: _____
2. Contractor: _____
 - a. Name: _____
 - b. Address: _____
 - c. Telephone: _____
3. Project: _____
 - a. Name: _____
 - b. Contract #: _____
4. Payment Amount: \$ _____
5. Period Covered: _____
6. Final Payment: _____

Contractor covenants and warrants to: _____
("Owner"), and certifies as follows:

1. All persons, firms, corporations and other entities furnishing labor, employee benefits, materials, equipment, and/or professional services in connection with the Project, at the request of and for or on behalf of the Contractor will be paid through the period stated in No. 5 above from funds to be received from this payment. No person, firm, corporation, or other entity who has furnished labor, employee benefits, materials, equipment and/or professional services to the Contractor for the Project, has any right to file a claim or lien against the Project or against the Contractor's bonds, or any retained percentage, except as follows (none, unless otherwise stated):
2. There are no federal, state or municipal taxes, warrants, levies, or other claims, charges, unpaid or delinquent, for which the Contractor or its subcontractors are responsible which constitute an encumbrance, claim, or lien against the Project, or the Contractor's bonds, or retained percentage. No government agency may file a warrant, lien, levy, or other encumbrance against the Project or against the Contractor's bonds or retained percentages, except as follows (none, unless otherwise stated):
3. The undersigned Contractor agrees to indemnify and hold the Owner harmless from any and all claims for payment which might be filed contrary to the representations made above and to defend any such claims without any cost, expense, or damages, to the Owner.
4. The undersigned Contractor, in consideration for the Payment Amount shown above, hereby forever releases the Owner, its sureties, and any bond or retainage from any and all claims for payment arising under or in connection with the Project during the period covered and accepts said payment as full compensation and consideration for all of the Work performed under this Contract.
5. This certificate is made by the undersigned Contractor with a full understanding of the facts set forth herein, and for the purpose of inducing the Owner to make payment to the Contractor on the assurance that there are no liens, claims or other encumbrances, except as described above.
6. The person signing this document, regardless of whether they are signing in representative capacity, specifically represents that they have reviewed the relevant records of the Contractor, and have personal knowledge that all lienable claims referred to above have been paid. The undersigned also represents that they have been duly authorized to sign this release and to make the representations set forth above on behalf of the Contractor.

Release and Certificate of Payment

I declare under penalty of perjury under the laws of the State of Washington that the foregoing statements are true and correct.

SIGNED this _____ day of _____, 20__.

Name and Title of Contractor

Contractor's License No, State, and Expiration Date

Testing Results Transmittal

To: Parametrix, Inc.
1019 39th Avenue SE, Suite 100
Puyallup, WA 98374

Project: _____ ATTN: _____ Date: _____
Project No.: _____
Owner: _____ Location: _____
Laboratory Name and Address: _____

Attach original copy of laboratory results and submit one form for each type of test conducted.

Use One Form for Each Type of Test Conducted:

Type of Test	Date	Person Taking Sample	Location/ Station	Test Results	Comments
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

Deviations or Additional Comments:

Contractor's Representation:

Company Name: _____

Printed name of Contractor's responsible person
submitting results: _____

Signature: _____

END OF SECTION

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1 **SECTION 02 41 00**

2 **DEMOLITION**

3 **PART 1 – GENERAL**

4 **1.01 SCOPE**

- 5 A. This section covers the removal of existing site features and equipment associated with
6 the relocation of the QVC 88th Street Pump Station Relocation as shown on the Drawings
7 and listed herein.

8 **1.02 SUBMITTALS**

- 9 A. Provide submittal data per Section 01 33 00, "Submittal Procedures."
10 B. Contractor shall provide a written plan detailing the proposed sequence of electrical
11 demolition work to demonstrate that continuous power supply will be provided to the
12 wastewater pumping facilities regardless of if they are existing, temporary, or the newly
13 constructed pump system. Plan shall be submitted for the Engineer's review.

14 **1.03 PROJECT CONDITIONS**

- 15 A. While the project is underway the Contractor shall coordinate with the Tribes to insure that
16 wastewater is conveyed in an uninterrupted manner.

17 **PART 2 – PRODUCTS**

18 **2.01 SALVAGE**

- 19 A. Salvage to the Tribes:
20 1. Traffic Counter Panel and all internal equipment. Notify Doug Bender of the Tulalip
21 Tribes at 360-926-2536 to coordinate the location for delivery of the equipment.
22 B. Property of Contractor:
23 1. Demolition, not indicated for salvage, becomes property of the Contractor, and shall
24 be removed from the site at the Contractor's expense to a legal waste site obtained by
25 the Contractor or recycled or sold.
26 2. Materials deemed to be non-salvageable by the Tribe shall be disposed by the
27 Contractor to a legal dump site obtain by him. All costs to dispose of non-salvageable
28 materials shall be the Contractor's responsibility.
29 3. Existing materials and equipment removed by the Contractor shall not be reused in
30 the work except where so specified or indicated.

1 **PART 3 – EXECUTION**

2 **3.01 GENERAL**

- 3 A. The Contractor shall remove all features indicated for removal on the demolition drawings.
- 4 B. There is no on-site disposal area for the demolition debris. The Contractor shall comply
5 with all regulations when disposing of the materials resulting from this demolition work.

6 **3.02 PREPARATION FOR DEMOLITION**

- 7 A. All demolition work shall be closely coordinated to achieve continuous conveyance of
8 wastewater from the site and into the force main.
- 9 B. Install all associated erosion control measures prior to conducting any demolition
10 activities.
- 11 C. Install barriers, shoring, and padding to protect existing structure, finishes, materials,
12 utilities, and systems not to be demolished.

13 **3.03 DEMOLITION**

- 14 A. Dispose of all demolished items. No items will be salvaged for the Tribe.
- 15 B. Demolish in an orderly and careful manner so as to protect existing work to remain.
- 16 C. Remove demolition materials as work progresses. Upon completion, leave areas in a
17 clean condition.
- 18 D. Transport demolition debris off site and dispose in a legal manner. The Contractor must
19 notify the Engineer of the disposal location and must also notify the disposal/recycle facility
20 if lead paint is present.
- 21 E. Provide disposal documents and receipts upon request.

22 **3.04 DAMAGED WORK**

- 23 A. Repair any portion of work damaged during demolition. Replace entirely where repair is
24 not practical or satisfactory to meet original condition of work.

25 **3.05 PREPARATION FOR CUTTING AND PATCHING**

- 26 A. Cut, move or remove items as necessary for access to alteration work. Replace and
27 restore at completion.
- 28 B. Remove debris and abandoned items, not designated for salvage.
- 29 C. Clean and prepare surfaces including removal of surface finishes to provide proper
30 installation and application of new work.

1 **3.06 PROTECTION**

- 2 A. Protect existing construction to remain, including systems, finishes, and equipment from
3 damage during construction.
- 4 B. Erect temporary enclosures and barriers. Seal off work areas from adjacent occupied
5 areas to protect from dust, noise and entry of unauthorized persons.

6 **3.07 PATCHING AND EXTENDING EXISTING WORK**

- 7 A. Remove, cut and prepare existing construction materials in manner to minimize damage
8 and to provide a means of restoring products and finishes to original condition, except as
9 otherwise indicated. Perform in manner to avoid damaging adjacent work.
- 10 B. Patch and extend existing work, filling holes and depressions. Match existing adjacent
11 work in texture and appearance and as specified for new work.
- 12 C. Patch floors, walls and ceilings with finish materials matching existing where partitions,
13 fixtures, utilities, equipment and such items are removed.
- 14 D. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest
15 intersection or natural break. For an assembly, refinish entire unit.

16 **3.08 REPAIR OF DAMAGED SURFACES**

- 17 A. Patch or repair portions of existing surfaces which are damaged, lifted, discolored, or
18 showing other imperfections.
- 19 B. Repair substrate prior to patching finish.

20 **3.09 FINISHES**

- 21 A. Finish of patches and repairs: Produce uniform texture and general appearance over
22 entire area. When surface finish cannot be matched, refinish entire surface to nearest
23 intersection.
- 24 B. Final finishes of finished surfaces: As specified under individual sections.

25 **END OF SECTION**

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1 c. Nut: Stainless steel conforming to ASTM F594 with chemical composition of
2 AISI Type 316 and meeting dimensional requirements of ANSI B18.2.2.

3 d. Washer: AISI Type 316 stainless steel conforming to ASTM A240.

4 2. Products:

5 a. Hilti, Kwik-Bolt TZ SS 316.

6 b. Powers Fasteners, Power-Stud + SD6.

7 c. Simpson Strong Tie, Strong-Bolt 2, Type 316 stainless steel.

8 d. Other manufacturers upon approval of Engineer.

9 C. Adhesive Anchors (Epoxy Anchors):

10 1. Adhesive anchors shall be used in all locations subject to wet/dry cycles.

11 2. Anchor rod material shall conform to AISI Type 316 stainless steel.

12 3. Products:

13 a. Hilti, HIT-RE 500-V3.

14 b. Powers Fasteners, PE1000+.

15 c. Simpson Strong-Tie, SET-XP.

16 d. Other manufacturers upon approval of Engineer.

17 D. Stainless Steel Plates and Shapes: Conform to AISI Type 316 unless otherwise noted.

18 **PART 3 – EXECUTION**

19 **3.01 INSTALLATION**

20 A. Coordinate the location and placement of all items to be embedded in concrete.

21 B. Coat any embedded aluminum with asphalt paint.

22 C. Adhesive and expansion anchors to be installed in holes drilled with carbide tipped drill
23 bits. Anchors shall be installed per manufacturer's recommendations. Insert and tighten
24 bolts in accordance with manufacturer's installation instructions. In case of interference
25 with reinforcing bars or steel objects, notify the Engineer.

26 **3.02 EMBEDDING**

27 A. Set accurately and hold in position all embedded products during placement until the
28 concrete is set.

1 **3.03 INSPECTION**

2 A. Anchors shall be inspected by Special Inspector as required by the Inspection
3 Requirements described in the Structural General Notes contained on the Drawings or as
4 required by the Building Official.

5 **END OF SECTION**

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- 1 C. Concrete Test Cylinders:
- 2 1. Owner will retain and pay for the services of an independent testing laboratory.
3 Contractor shall coordinate and cooperate with testing service and the Engineer to
4 perform the following:
- 5 a. Prepare a minimum of three test cylinders for each location (slab, wall, etc.) for
6 each day's placement or every 50 cubic yards, whichever is less.
- 7 2. Test set of three cylinders as follows:
- 8 a. One at 7 days.
9 b. Two at 28 days.
- 10 3. Prepare and test cylinders per ASTM C31 and C39.
- 11 D. Prior to placement, have available at placement location all tools, cylinder molds,
12 slump cone, rod, curing containers, and all other apparatus required for sampling and
13 testing.
- 14 E. Air Entrained: One test for each pour.

15 **1.04 SUBMITTALS**

- 16 A. Concrete-Mix Designs:
- 17 1. Submit two copies of trial mix designs proposed and one copy each of 30 consecutive
18 test results and the mix design used from a record of past performance in accordance
19 with ACI 301.
- 20 2. Submit manufacturer's certification of meeting these Specifications for materials
21 proposed including names, sources, descriptions, and warranties for cement, fly-ash,
22 grouts, water reducing admixtures, epoxy bonding materials, and curing compounds.
- 23 3. Submit a sample ready-mixed concrete delivery ticket.
- 24 B. Curing Compounds.
- 25 C. Admixtures.
- 26 D. Reinforcing Steel:
- 27 1. Placing drawings, bending, and cut sheet schedules.
28 2. Mill test reports for each shipment of reinforcement.

1 **1.05 DELIVERY, STORAGE, AND HANDLING**

2 A. Concrete:

3 1. A. Maintain in continuous clean environment and in manner required to
4 maintain homogeneity.

5 2. Cements, grouts, and mortar containerized and kept in dry humidity environment.
6 Engineer shall reject materials, which have hardened or show any evidence of initial
7 hydration.

8 B. Reinforcing Steel:

9 1. Deliver reinforcement to project site in bundles marked to coordinate with
10 placement drawings.

11 2. Handle and store to prevent contamination from dirt, oil, and other materials, which
12 will affect bond.

13 3. Store a minimum of 6 inches above ground and in locations where the material will not
14 be subject to abuse.

15 **PART 2 – PRODUCTS**

16 **2.01 CONCRETE**

17 A. ASTM C94 and mix design approved by Engineer.

18 B. Strength:

19 1. Schedule (except as noted on Drawings):

<u>Type of Structure</u>	<u>Minimum Compressive Strength</u>	<u>Maximum Water/Cement Ratio</u>
Concrete Tanks and water-containing structures	5,000 psi at 28 days	0.40
Building Structures (foundations, and slabs)	4,000 psi at 28 days	0.45
Miscellaneous Structures (equipment pads, etc.)	4,000 psi at 28 days	0.50
Duct bank or pipe encasement	2,500 psi at 28 days	Per supplier mix design

20 2. Cementitious Content:

21 a. For 5,000 psi concrete, shall not be less than 610 pounds per cubic yard.

22 b. For 4,000 psi concrete, shall not be less than 520 pounds per cubic yard.

23 3. Entrained air 5-1/2 plus or minus 1%, for tanks and exterior concrete. Not required for
24 interior slabs.

- 1 4. Maximum slump 3 inches; 4 inches for walls (without use of water-reducing
2 admixtures). Where water-reducing admixtures are required to increase workability
3 necessary to facilitate placement of low water, cement ratio concretes, slump range
4 may be 6 to 11 inches in strict accordance with manufacturer's recommendations.
- 5 C. Cement ASTM C150: Type I or Type II for all structures.
- 6 D. Aggregates:
- 7 1. Maximum aggregate size 3/4 inch conforming to ASTM C33, grading No. 67.
- 8 2. Maximum wear 50% at 500 revolutions, AASHTO 96.
- 9 E. Water: Clear, free from injurious amounts of oil, acid, salt, alkali, organic matter, or other
10 deleterious substances.
- 11 F. Admixtures:
- 12 1. Shall be subject to approval of the Engineer:
- 13 a. General:
- 14 1) Use only those specified in approved mix design.
- 15 2) Apply in strict accordance with manufacturer's printed instructions.
- 16 3) No chloride content permitted.
- 17 4) Must be compatible with other admixtures.
- 18 2. Air-Entraining Agent: Air entrainment admixtures shall conform to ASTM C260.
- 19 3. Water-Reducing Admixture: Water-reducing admixture shall conform to ASTM C494,
20 Type A.
- 21 4. High-Range Water-Reducing Admixture: High-range water-reducing admixture
22 (superplasticizer) shall conform to ASTM C494, Type G.
- 23 5. Accelerating Admixture: Accelerating admixture, when used, shall conform to
24 ASTM C494, Type E.
- 25 6. Retarding Admixture: Retarding admixture, when used, shall conform to ASTM C494,
26 Type D.

27 **2.02 CURING MATERIALS**

- 28 A. Polyethylene Sheeting: 0.004-inch thick.
- 29 B. Waterproof Paper: Polyethylene-coated, Federal Specification UU-B-790 Type I, Grades
30 A, B, C, Style 4. Define lap control lines clearly by printed markings.

1 C. Membrane Forming Compound: Conform to ASTM C309.

2 **2.03 CONTROLLED DENSITY FILL (CDF) CONTROLLED DENSITY FILL (CDF)**

3 A. Controlled Density Fill (CDF) or Controlled Low-Strength Material (CLSM) – a self
4 compacting, cementitious, flowable material requiring no subsequent vibration or tamping
5 to achieve consolidation. The Contractor shall provide a mix design in writing to the
6 Engineer and utilize ACI 229 as a guide to develop the CDF mix design. CDF shall be
7 designed to have a minimum 28-day strength of 50 psi and a maximum 28-day strength
8 not to exceed 150 psi. The CDF consistency shall be flowable (approximate slump 3 to
9 10 inches).

10 B. The following testing methods shall be used by the Contractor to develop the CDF
11 mix design:

12 1. 28-day compressive strength – ASTM D4832.

13 2. Unit weight, yield, and air content – ASTM D6023.

14 3. Slump – FOP for AASHTO T 119.

15 **2.04 MISCELLANEOUS CEMENTITIOUS MATERIALS**

16 A. For Fill (Manhole or Basin Bottom Fill): 400 pounds of cement, 120 pounds of fly ash per
17 cubic yard of concrete, 3/8-inch-maximum aggregate, W/C = 0.45.

18 **2.05 REINFORCEMENT**

19 A. Reinforcing Bars:

20 1. ASTM A615, grade 60, unless otherwise shown, using deformed bars for Number 3
21 and larger.

22 2. Bending – ACI 318.

23 B. Welded Wire Fabric:

24 1. Steel, conforming to ASTM A185, 65 ksi yield strength. Supply in sheets; rolls are
25 not acceptable.

26 C. Tie Wire:

27 1. Steel, black annealed, 16-gauge minimum.

28 D. Reinforcing Bar Supports:

29 1. Per CRSI “Manual of Standard Practice,” Chapter 3, pre-galvanized or plastic coated
30 for chairs bearing on non-exposed surfaces, plastic or stainless steel for chairs or
31 spacers in exposed work.

1 E. Fabricate reinforcement to the required shapes and dimensions, within fabrication
2 tolerances stated in the CRSI.

3 F. Do not use reinforcement having any of the following defects:

4 1. Bar lengths, depths, or bends exceeding the specified fabricating tolerances.

5 2. Bends or kinks not indicated on the Drawings or required for this work.

6 3. Bars with cross-section reduced due to excessive rust or other causes.

7 **2.06 OTHER MATERIALS**

8 A. Provide other materials, not specifically described but required for a complete and proper
9 installation, as selected by the Contractor.

10 **PART 3 – EXECUTION**

11 **3.01 EXISTING CONDITIONS**

12 A. Examine the areas and conditions under which work of this section will be performed.
13 Correct conditions detrimental to timely and proper completion of the work. Do not proceed
14 until unsatisfactory conditions are corrected.

15 **3.02 EMBEDDED ITEMS**

16 A. Do not embed piping or electrical conduit in structural concrete unless indicated on the
17 Drawings or approved by the Engineer.

18 B. Set and secure bolts, inserts, and other required items in the precise locations needed so
19 these items are not displaced.

20 C. Prior to concrete placement, ensure the actual locations of embedded items are noted on
21 the as-built set of drawings.

22 **3.03 FORMS**

23 A. Design, erect, support, brace, and maintain formwork to safely support vertical and lateral
24 loads which will be applied until such loads can be supported safely by the concrete
25 structure.

26 B. Construct forms to the exact sizes, shapes, lines, and dimensions shown, and as required
27 to obtain accurate alignment, location, grades, and level and plumb work in the
28 finished structure.

29 **3.04 MIXING CONCRETE**

30 A. Transit mix the concrete in accordance with provisions of ASTM C94.

31 B. Do not use concrete that has stood for over 30 minutes after leaving the batch plant, or
32 concrete that is not placed within 90 minutes after water is first introduced into the mix.

1 **3.05 PLACING CONCRETE**

- 2 A. Deliver only in sufficient quantities required for specified time interval use and placement.
3 Discard concrete having initial set before placement. No remixing with water or
4 supplementing with other materials will be permitted once initial set has occurred. Initial
5 set as evidenced by typical hydration characteristics to be determined by Engineer.
- 6 B. Place as nearly as possible to final position to avoid segregation of the materials and
7 displacement of reinforcement. Placement shall be completed within 60 minutes after
8 water is first added to the mix. However, at the Engineer's discretion if climatic and
9 temperature conditions are suitable and when the concrete is continually agitated, the time
10 may be extended to 1-1/2 hours.
- 11 C. Do not change consistency (slump) for a given placement without the Engineer's
12 written permission.
- 13 D. Keep open trough and chutes of steel or steel lined clean and free from coatings of
14 hardened concrete.
- 15 E. Do not drop concrete a distance of more than 4 feet or through a cage of reinforcing steel
16 unless concrete is designed flowable with the specified superplasticizer included in the
17 mix, then concrete can free fall up to 10 feet.
- 18 F. Layout and sequence of placing of concrete in monolithic structures as shown on the
19 Drawings or approved by the Engineer.
- 20 G. Within a placement, deposit concrete in horizontal layers not to exceed 24 inches in depth.
21 Place at rate such that:
- 22 1. No concrete surface shall obtain initial set before additional concrete is placed on it.
- 23 2. Yielding of forms is not so great as to cause the concrete surfaces to exceed the
24 tolerances specified.
- 25 H. Unless specified otherwise, place all slabs and finished floors to finish elevation in one
26 continuous operation, except that the Contractor may place a separate finish topping if
27 prior approval is received from the Engineer. Floor and roof slab sectional thicknesses
28 shown are minimum thicknesses. Slopes on floors or roofs increase, rather than decrease,
29 slab thicknesses.
- 30 I. Construction Joints:
- 31 1. Limit size of each slab or wall pour as shown on the Drawings, or as approved by
32 the Engineer.
- 33 2. Locate construction joints so as not to impair the strength of the structure, and only at
34 locations shown on the shop drawings or approved by the Engineer.
- 35 3. Construct bulkheads to neatly fit reinforcement and water stops and prevent
36 concrete leakage.

- 1 4. Provide water stops or sealants in construction joints where required.
- 2 5. Continue reinforcement through construction joint unless otherwise shown or noted.
- 3 6. When noted, alternate pour at each side of construction joints with specified minimum
4 curing time between pours.
- 5 7. Before placing concrete against previously placed concrete, thoroughly roughen and
6 clean by wet sandblasting or green cutting with an air-water jet:
- 7 a. Use air-water cutting at the proper time after the initial set. Use a high-pressure
8 air-water jet to expose clean, sound aggregate without undercutting the edges of the
9 larger aggregate. Protect adjacent subgrade when cutting is used on slab edges.
- 10 b. After cutting or sandblasting, rinse the surface until wash water contains no
11 cloudiness. Dispose of wastes from cutting, washing, and rinsing so wastes do not
12 stain or abrade exposed surfaces.
- 13 8. Place concrete continuously to a predetermined construction joint.
- 14 J. Care shall be taken in placing concrete through reinforcements so that no segregation of
15 the coarse aggregate occurs. In any placement where segregation may occur, the
16 concrete shall be designed flowable and placed at 6 inches plus slump. Vibrators shall be
17 inserted no farther than 3 feet from the point of placement of concrete into forms, as
18 concrete is being placed.
- 19 K. Special care shall be taken to prevent splashing forms or reinforcement with concrete. Any
20 hardened concrete or partially hardened concrete on the forms or reinforcements above the
21 level of the concrete already in place shall be removed before proceeding with the work.
- 22 L. Cold Weather Placement:
- 23 1. Concrete shall be placed only when the temperature is at least 40°F, and rising, unless
24 permission to pour is obtained from the Engineer.
- 25 2. Material shall be heated and otherwise prepared so that batching and mixing can
26 proceed in full accord with the provisions of this Specification.
- 27 3. Suitable means shall be provided for maintaining the concrete at a temperature of at
28 least 50°F for a period of at least the first 5 days and at a temperature above freezing
29 for the remainder of the specified curing period, except that where high-early-strength
30 cement is used, this period may be reduced to 72 hours. The methods proposed for
31 heating the materials and protecting the concrete shall be approved by the Engineer.
- 32 4. Salts, chemicals, or other materials shall not be mixed with concrete for the purpose
33 of preventing freezing.
- 34 M. Hot Weather Placement:
- 35 1. The temperature of fresh concrete at the time of placement during hot weather shall
36 be a maximum of 90°F, to prevent an accelerated setting of the concrete.

1 2. A retarding densifier admixture shall be used when the high expected atmospheric
2 temperature for the day is 85°F or above. Admixture shall be used in accordance with
3 the manufacturer's recommendations.

4 N. Placing Concrete Against Earth:

5 1. Unless otherwise called for on the Drawings, earth cuts shall not be used as forms for
6 vertical surfaces without the prior approval of the Engineer.

7 2. Concrete placed on or against earth shall be placed only upon or against firm, damp
8 surfaces free from frost, ice, and standing or running water. Concrete shall not be
9 placed upon mud or upon fills until the required compaction has been obtained.

10 **3.06 COMPACTING**

11 A. Compact all concrete with high-frequency internal vibrators immediately after placing.

12 B. Use external vibrators for compacting concrete where the concrete is inaccessible for
13 adequate compaction by internal vibrators; construct forms sufficiently rigid to resist
14 displacement or damage from external vibration.

15 C. Use mechanical vibrating equipment, always keeping the vibrator within 3 feet of the
16 discharge point into the form. For exposed concrete surfaces and architectural concrete,
17 keep the vibrator on the unexposed side of the reinforcing steel or at least 2-1/2 inches
18 from the form surface. Vibrate the concrete as the concrete is being placed to prevent
19 honeycomb, rock pockets, and voids. Do not insert vibrators into lower layers of concrete
20 that have begun to set. Vibration required on flowable concrete is about one-fourth that
21 needed for 4-inch-slump concrete.

22 **3.07 CURING AND PROTECTION**

23 A. General:

24 1. Maintain at site, ready to install, before actual concrete placing begins, all equipment
25 and materials needed for optimum concrete curing and protection; maintain extra
26 vibrators on standby in case of malfunction of any unit.

27 2. Protect finished surfaces or edges from stains, abrasions, and breakage during the
28 entire construction period.

29 3. Protect all concrete from accelerated drying and excessive heat at all times. Close all
30 conduits and other formed openings through the concrete during the entire curing period
31 and as long thereafter as practicable to prevent drying of concrete by air circulation.

32 4. Install slab-curing covers immediately after initial set or as soon as free water has
33 disappeared from the surface of the concrete after finishing or surfacing.

34 B. Water Curing (use water curing specified herein for all walls and slabs where watertight
35 construction is required):

36 1. Keep continuously wet by covering with an approved material or by a system of
37 perforated pipes or mechanical sprinklers or other approved methods.

- 1 2. Keep forms wet at all times to prevent opening of joints and the drying out of
2 the concrete.
- 3 3. Water for curing shall be clean and free from any elements, which might cause
4 objectionable staining or discoloration of the concrete.
- 5 4. Cover surfaces completely with sheeting. Where a single sheet does not cover the
6 entire surface, lap ends and edges at least 4 inches, and continuously seal with tape
7 or other suitable means recommended by the manufacturer.
- 8 5. Continue waterproof sheet curing for 7 days. Maintain sheeting and edge and end
9 seals intact for entire period. Repair immediately any breaks in the sheeting envelope.
- 10 C. Curing Compounds (use only when specifically approved and for optimum climatic
11 conditions):
- 12 1. Do not use curing compounds unless this use is authorized in writing by the Engineer.
13 Curing compounds are unacceptable where concrete is exposed to the direct rays of
14 the sun or in accelerated drying conditions.
- 15 2. All interior slabs shall have membrane-forming compounds that meet the moisture
16 retention required by ASTM C309 when applied at a normal single coat.
- 17 3. Prior to applying curing compounds to formed surfaces, the surfaces shall be
18 moistened with a spray of water immediately after forms are removed. Moistening shall
19 be continued until the surfaces will not readily absorb more water. The compound shall
20 be applied as soon as the moisture film has disappeared and while the surface is
21 still damp.
- 22 4. On slabs, the compounds shall be applied immediately after finishing and after
23 bleeding water and "shine" has disappeared.
- 24 5. Curing compounds shall not be used on surfaces where future bonding, painting, or
25 protective coating is required. In cold weather, curing compounds shall not be used on
26 concrete surfaces, which are kept at curing temperature, by the use of steam.

27 **3.08 CONCRETE FINISHING**

- 28 A. Unless otherwise indicated, provide the following finishes at the indicated locations.
- 29 1. Non-slip broom finish: apply to slabs, walks, stairs, drives, ramps, and similar
30 pedestrian and vehicular areas.
- 31 2. Formed surfaces: repair all rock pockets, voids, air bubbles, etc. greater than 1/2 inch
32 in any dimension.
- 33 B. Round off all edges of slabs and tops of walls with a steel-edging tool, except where a
34 cove finish is shown. Steel edging tool radius shall be 1/4 inch for all slabs subject to
35 wheeled traffic.

1 **3.09 TOLERANCES**

2 A. Unless otherwise required, allowable tolerances for concrete surfaces shall be in
3 accordance with those shown in the table below. Surface irregularities are classified as
4 either “abrupt” or “gradual.” Offsets caused by displaced or misplaced form sheathing,
5 lining, or form section or by defective form lumber shall be considered as abrupt
6 irregularities. All others are classed as gradual irregularities. Gradual irregularities shall be
7 measured with a template consisting of a straight edge for plane surfaces and its
8 equivalent for curved surfaces.

9 B. The length of the template for testing formed surfaces is 5 feet. The length of the template
10 for unformed surfaces is 10 feet. Maintain a 5-foot-long and a 10-foot-long steel template
11 on the job site.

12 C. Maximum Allowable Irregularities in Concrete:

<u>Location</u>	<u>Irregularity in Inches</u>	
	<u>Gradual</u>	<u>Abrupt</u>
Walls	1/4	3/16
Slabs	1/4	1/4

13 **3.10 UNSATISFACTORY CONCRETE**

14 A. Any concrete placed which fails to meet or exceed the specified strength requirements as
15 determined from molded cylinders, or cores, or to meet the density or surface
16 requirements, or which has been frozen during placing or curing, shall be removed and
17 replaced with satisfactory materials at the Contractor’s expense.

18 B. Method of Determining Unsatisfactory Concrete: Visual appearance characteristic of rain
19 or freeze damage to concrete which is apparent to the Engineer.

20 **3.11 BONDING TO OLD CONCRETE**

21 A. Clean existing concrete surfaces by using wet sandblast or high pressure water jet to
22 remove the surface film and contaminants. Roughen to 1/4-inch amplitude or as shown
23 on the Drawings.

24 B. Coat the contact surfaces with bonding agent. Apply the bonding agent in conformance
25 with the manufacturer’s instructions.

26 C. As concrete is placed, thoroughly vibrate against the contact surface.

27 **3.12 REINFORCING INSTALLATION**

28 A. Placement and Tolerances: Conform to CRSI Manual of Standard Practice.

29 B. Splices:

30 1. Do not splice bars except at locations shown or noted on the Drawings or as otherwise
31 approved.

1 **SECTION 03 40 00**

2 **PRECAST CONCRETE VAULTS**

3 **PART 1 – GENERAL**

4 **1.01 DESCRIPTION**

5 A. This section covers furnishing and installation of special purpose precast concrete vaults,
6 manholes, and catch basins.

7 B. See Section 08 34 00, "Floor Doors" for vault hatches.

8 **1.02 ADAPTATION OF PRODUCT**

9 A. Furnish product readily adaptable for installation and operation in the manner shown on
10 the Drawings.

11 **1.03 SUBMITTALS**

12 A. Provide submittal data per Section 01 33 00, "Submittal Procedures."

13 B. Shop drawings showing detailed dimensions, block outs, and specifications for materials
14 used, parts, devices, and other accessories forming part of the vault.

15 **PART 2 – PRODUCTS**

16 **2.01 DESIGN**

17 A. Conform to ASTM C913.

18 B. Design for 16,000-pound wheel load, AASHTO H-20.

19 **2.02 FABRICATION**

20 A. Precast elements shall provide for watertight sealing of mating surfaces using epoxy grout,
21 field applied.

22 B. Openings shall be located and sized as dimensioned on the Drawings. Where drains are
23 connected to piping below the base of the precast unit, provide adequate opening with
24 keyway to facilitate a field installation and grouting of base drains and trap units as shown
25 on the Drawings. Standard products may be used where provision exists for achieving the
26 configuration shown on the Drawings.

1 C. Embedded items shall be provided in the tops, walls, and bases where indicated on the
2 Drawings.

3 D. Buried exterior of vaults shall be factory coated with black bituminous coating to a
4 minimum dry film thickness of 10 mils.

5 **2.03 LADDER RUNGS**

6 A. Shall be as detailed on drawings.

7 B. Conform to OSHA.

8 C. Designed so that foot cannot slide off the ends.

9 D. Space rungs at 12 inches and locate as shown on the Drawings.

10 E. Project uniformly inside wall.

11 F. Where indicated on the Drawings, provide stainless steel ladder safety post Bilco LU-3
12 LadderUp Type 304 stainless steel with sand blast finish or equal.

13 **PART 3 – EXECUTION**

14 **3.01 INSTALLATION**

15 A. Foundation materials, including over-excavation, ballast, structural fill, geotextile, and/or
16 geogrid, shall be provided for all structures in conformance with the project geotechnical
17 report.

18 B. Foundation bedding material shall be brought to precise elevations called for on the
19 Drawings and leveled if required.

20 C. Install structure and accessories in conformance with Drawings, Specifications, and
21 recommendations of vault manufacturer unless otherwise instructed in writing by the
22 Engineer. Vault location and orientation shall conform to the Drawings.

23 D. The structure joints, pipeline, and conduit penetrations through walls, as shown on the
24 Plans, shall be sealed watertight using epoxy cement grout. No leakage will be allowed
25 into the structure.

26 **END OF SECTION**

1 **SECTION 03 60 00**

2 **GROUTING**

3 **PART 1 – GENERAL**

4 **1.01 SUMMARY**

- 5 A. This section specifies nonshrink grout and epoxy grout for use in applications including
6 but not limited to grouts for leveling machine bases to equipment pads, manhole masonry
7 units, joints between precast concrete sections, and grouting under base plates. Epoxy
8 adhesives for concrete applications including, but not limited to pressure injection of
9 cracks and doweling of anchor bolts, threaded rod anchors and reinforcing bar dowels.

10 **1.02 QUALITY CONTROL**

- 11 A. Referenced Standards: This section incorporates by reference the latest revision of the
12 following documents. These references are a part of this section as specified and modified.
13 In case of conflict between the requirements of this section and those of the listed
14 documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ASTM C33	Concrete Aggregates
ASTM C40	Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C88	Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Test Method for Materials Finer than No. 200 Sieve in Mineral Aggregates by Washing
ASTM C136	Test Method for Sieve Analysis of Fine and Course Aggregates
ASTM C150	Portland Cement
ASTM C289	Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C881	Standard for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C1017	Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM E329	Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
CRD-C-621	Corps of Engineers Specification for Nonshrink Grout

15 **1.03 SUBMITTALS**

- 16 A. Manufacturer's Data for the following:

- 1 1. Nonshrink cementitious grout.
- 2 2. Epoxy grout.
- 3 3. Admixtures for cement grout.
- 4 4. Adhesive for pressure injection of cracks.
- 5 5. Adhesive for doweling.
- 6 6. Retardants.
- 7 7. Bonding compounds.
- 8 B. Certified Test Reports: Before delivery of materials or grout, submit certified reports of the
- 9 tests specified herein. Accompany the certified reports on previously tested materials with
- 10 the manufacturer's certified statement that the previously tested material is of the same type,
- 11 quality, manufacture, and make as that proposed for use in this Contract. Certified test
- 12 reports are required for all cement grout constituents, including cement and aggregates.

13 **PART 2 – PRODUCTS**

14 **2.01 GENERAL**

- 15 A. Grout mixes and admixtures shall not contain more than 0.05% chloride ions.
- 16 B. Water for washing aggregate, for mixing, and for curing:
 - 17 1. Shall be free from oil and deleterious amounts of acids, alkalis, and organic materials.
 - 18 2. Shall not contain more than 1,000 mg/L of chlorides as Cl, nor more than 1,300 mg/L
 - 19 of sulfates as SO₄.
 - 20 3. Shall not contain an amount of impurities that may cause a change of more than 25% in
 - 21 the setting time of the cement nor a reduction of more than 5% in the compressive strength
 - 22 of the grout at 14 days when compared with the result obtained with distilled water.
 - 23 4. Water used for curing shall not contain an amount of impurities sufficient to discolor
 - 24 the grout.

25 **2.02 GROUT**

- 26 A. Use grout specified on the Contract Plans or as specified in the equipment
- 27 recommendations.
- 28 B. Nonshrink cementitious grout:
 - 29 1. Cementitious grout that conforms to ASTM C1107, CRD-C-621, "Corps of Engineers
 - 30 Specification for Non-Shrink Grout," and the following requirements:
 - 31 a. Nonmetallic aggregate.

- 1 b. Acceptable manufacturers:
- 2 1) Euclid Chemical Co., "Euco NS."
- 3 2) BASF, "Masterflow 713 Plus."
- 4 3) Five Star Grout Co., "Five-Star Grout."
- 5 4) Or approved equal.

6 C. Epoxy Grout:

- 7 1. Multi-component, 100% solids compound conforming to the following requirements:
- 8 a. Suitable for use on dry or damp surfaces.
- 9 b. Comply with ASTM C881.
- 10 c. Acceptable manufacturer:
- 11 1) Euclid Chemical Co., "DuralBond."
- 12 2) Sika Chemical Co, "Sikadur 35 Hi-Mod LV."
- 13 3) BASF, "SCB Coneresive 1380."
- 14 4) Or approved equal.

15 D. Cement Grout:

- 16 1. A mixture of 1 part portland cement, 1 to 2 parts fine aggregate, and with sufficient
- 17 water to impart workability but not such that the grout will flow:
- 18 a. Cement shall be portland cement, ASTM C150 Type II or Type V, and shall be low
- 19 alkali cement, containing less than 0.60% alkalis.
- 20 b. Fine aggregate shall conform to ASTM C33 and to the following requirements:
- 21 1) Nonreactive and washed before use.
- 22 2) When sources of aggregate are changed, provide test reports for the new
- 23 material. Perform the tests specified prior to commencing grout work.
- 24 3) Fine aggregate shall be hard, dense, durable particles of either sand or
- 25 crushed stone regularly graded from coarse to fine.
- 26 4) When tested in accordance with ASTM C136, gradation of fine aggregate shall
- 27 be such that 100% by weight will pass a standard No. 8 mesh sieve and no
- 28 less than 45% by weight will pass a standard No. 40 mesh sieve.

1 5) Variation from the specified gradations in individual tests of fine aggregates will
2 be accepted if the average of three consecutive tests is within the specified
3 limits and the variation is within the permissible variation listed below.

4 6) Comply with ASTM C33 as modified herein.
5

U.S. Standard Sieve Size	Permissible Variation, Percent
30 or coarser	2
50 or finer	0.5

6 7) Other tests shall be in accordance with the following specifications:
7

Test Method	Test	Requirements
ASTM C40	Organic Impurities	Color lighter than standard
ASTM C117	Passing 200 sieve	3% maximum
ASTM C88	Soundness	10% max loss with sodium sulfate
ASTM C289	Reactivity	Innocuous aggregate
ASTM D2419	Sand Equivalent	Minimum 80

8 E. Admixtures:

9 1. Admixtures shall be compatible with the grout and shall conform to the following
10 requirements:

11 a. Calcium chloride, thiocyanates or admixtures containing more than 0.05% chloride
12 ions are not permitted.

13 b. Use admixtures in accordance with the manufacturer's recommendations and add
14 separately to the grout mix.

15 c. Chemical admixtures for flowing concrete grout shall comply with ASTM C1017.

16 d. Water reducing, retarding admixture:

17 1) The admixture shall comply with ASTM C494 Type D requirements and not
18 contain more chloride ions than are present in municipal drinking water.

19 2) Acceptable manufacturers:

20 a) Euclid Chemical Co., "Eucon Retarder-75."

21 b) BASF, "Pozzoloth 100 XR."

22 c) Sika Corporation, "Plastiment."

23 d) Or approved equal.

1 **2.03 ADHESIVES**

2 A. Adhesive for pressure injection of cracks in concrete:

3 1. A two-component, moisture tolerant, low viscosity, liquid epoxy adhesive conforming
4 to ASTM C881 for load-bearing applications.

5 2. Acceptable manufacturers:

6 a. BASF, "SCB Concrecive 1350 or 1360."

7 b. Sika Chemical Co, "Sikadur 35 Hi-Mod LV."

8 c. Euclid Chemical Co., "Eucopoxy Injection Resin."

9 d. Or approved equal.

10 B. Adhesive for doweling of anchors and reinforcing bars in concrete:

11 1. A two-component, moisture tolerant, epoxy gel conforming to ASTM C881 for
12 load-bearing applications.

13 2. Acceptable manufacturers:

14 a. Euclid Chemical Co., "Euco #452."

15 b. Sika Corporation, "Sikadur Anchor Fix-4."

16 c. Simpson Strong Tie., "Set XP."

17 d. Hilti, "HIT RE 500SD."

18 e. BASF, "SCB Concrecive 1380."

19 f. Or approved equal.

20 **PART 3 – EXECUTION**

21 **3.01 GENERAL**

22 A. Mix, place and cure in accordance with the manufacturer's instructions.

23 B. For grouting of equipment base plates, refer to manufacturer's instructions for appropriate
24 procedures.

25 **3.02 EXAMINATION**

26 A. Inspect concrete surfaces to receive grout or mortar and verify that they are free of ice,
27 frost, dirt, grease, oil, curing compounds, paints, impregnations, and all loose material or
28 foreign matter likely to affect the bond or performance of grout or mortar.

- 1 B. Inspect base plate and anchor systems for rust, oil, and other deleterious substances that
2 may affect the bond or performance of grout.
- 3 C. Confirm that newly placed concrete has been cured sufficiently to attain its design strength
4 and limit further shrinkage.
- 5 D. Verify that temperature of cementitious or epoxy grout does not exceed manufacturer's
6 recommendations.

7 **3.03 PREPARATION**

8 A. Surface Preparation:

- 9 1. Roughen all concrete surfaces by heavy sandblasting, chipping, or other mechanical
10 means to ensure bond. Loose or broken concrete shall be removed.
- 11 2. All grease, oil, dirt, curing compounds, laitance, and other deleterious materials that
12 may affect bond that were identified in the inspection process shall be completely
13 removed from concrete and bottoms of base plates. All metal surfaces should have a
14 2- to 3-mil peak-to-valley profile for epoxy grouts.
- 15 3. For cementitious mortars and grouts, concrete shall be saturated surface damp. Any
16 standing water shall be removed prior to placing grouts.
- 17 4. For epoxy grouts, do not wet concrete surfaces with water. Instead, where required,
18 wet surfaces with epoxy for horizontal work or epoxy gel for vertical or overhead work
19 prior to placing epoxy grouts.

20 B. Forms and Headboxes for Cementitious or Epoxy Grouts:

- 21 1. Forms for grouts shall be built of material with adequate strength to withstand the
22 placement of grouts.
- 23 2. Forms must be rigid and liquid tight. All cracks and joints shall be caulked with an
24 elastomeric sealant. All forms shall be lined with polyethylene for easy grout release.
25 Forms carefully waxed with two coats of heavy-duty paste wax shall also be
26 acceptable.
- 27 3. Forms shall be 4 to 6 inches higher than the base plate on one side of the base plate
28 configuration when using head pressure for placement.
- 29 4. A sufficient number of headboxes shall be built to facilitate placement of grouts.
- 30 5. Air relief holes a minimum 1/8 inch in diameter shall be provided when required by a
31 base plate configuration to avoid entrapping air underneath.

32 **3.04 NONSHRINK CEMENTITIOUS GROUT**

- 33 A. Prepare concrete surfaces in accordance with the grout manufacturer's instructions.
- 34 B. Do not retemper grout by adding more water after stiffening.

1 **3.05 EPOXY GROUT**

- 2 A. Prime concrete in accordance with the grout manufacturer's instructions.
- 3 B. Epoxy grouts shall be mixed in complete units. Do not vary the ratio of components or add
4 solvent to change the consistency of the mix.
- 5 C. Mix until aggregate is uniformly wetted. Over mixing will cause air entrapment in the mix.

6 **3.06 PRESSURE INJECTION OF CRACKS**

- 7 A. Design system to permit injection of adhesive resin at pressures up to 50 psi.
- 8 B. Injection Equipment:
- 9 1. Include a mixer and holdover agitator tanks.
- 10 2. Provide gauges to indicate pressure used.
- 11 3. Provide a meter capable of indicating the volume of grout used to 1/10 of a cubic foot.

12 **3.07 DOWEL INSTALLATION**

- 13 A. Install per adhesive manufacturer's instructions.
- 14 B. Obstructions in Drill Path:
- 15 1. Locate holes in existing concrete to miss existing reinforcing. Prior to drilling holes,
16 field verify and mark the location of existing reinforcing using a pachometer or other
17 approved locating equipment.
- 18 2. When reinforcing steel is encountered in the drill path, slant drill to clear obstruction.
19 Drill shall not be slanted more than 10 degrees. Where slanting the drill does not
20 resolve the conflict the Contractor shall stop and notify the owner representative and
21 resolve the conflict to the satisfaction of the owner representative.
- 22 3. Abandoned dowel or anchor holes shall be completely filled with nonshrink grout and
23 struck off flush with the adjacent surface.

24 **3.08 CURING**

- 25 A. Cementitious Grouts:
- 26 1. Clean equipment and tools as recommended by the grout manufacturer.
- 27 2. Cure Grouts in accordance with manufacturer's specifications and recommendations.
28 Keep grout moist for a minimum of 3 days. The method needed to protect grouts will
29 depend on temperature, humidity, and wind. Wet burlap, a soaker hose, sun shading,
30 ponding, and, in extreme conditions, a combination of methods shall be employed.

1 3. Grouts shall be maintained above 40°F until they have attained a compressive
2 strength of 3,000 pounds per square inch, or above 70°F for a minimum of 24 hours
3 to avoid damage from subsequent freezing.

4 B. Epoxy Grouts:

5 1. Cure grouts in accordance with manufacturers' specifications and recommendations.
6 Do not wet cure epoxy grouts.

7 2. Consult the manufacturer for appropriate cure schedule. In no case should any surface
8 in contact with epoxy grout be allowed to fall below 50°F for a minimum of 48 hours
9 after placement.

10 **3.09 TESTING**

11 A. To ensure compliance with the specified requirements for grout, provide the services of an
12 independent testing laboratory that complies with the requirements of ASTM E329,
13 ASTM C109, and ASTM C579, Method B.

14 B. The testing laboratory will sample and test grout materials and submit results to the owner
15 representative.

16 C. During the course of construction, the owner representative may take separate field
17 samples of the following materials for confirming tests:

18 1. Cement.

19 2. Aggregates.

20 3. Cement grout mixture.

21 4. Commercially manufactured grout products.

22 **END OF SECTION**

- 1 F. The leaves shall securely latch when closed.
- 2 G. Frame and door shall be aluminum, welded plate or extruded sections, as required.
- 3 Surfaces of aluminum embedded or in contact with concrete shall be coated
- 4 with bituminous paint for corrosion protection.

5 **PART 3 – EXECUTION**

6 **3.01 INSTALLATION**

- 7 A. Comply with manufacturer's instructions for installation of access doors.
- 8 B. Coordinate installation with work of other trades.
- 9 C. Connect drain from channel frame as indicated.
- 10 D. Set frames accurately in position and securely attach to supports with face panels plumb
- 11 or level in relation to adjacent finish surfaces.
- 12 E. Provide airtight gasketing on floor doors over wet well.

13 **3.02 ADJUST AND CLEAN**

- 14 A. Adjust hardware and doors after installation for proper operation.
- 15 B. Remove and replace doors or frames that are warped, bowed, or otherwise damaged.

16 **END OF SECTION**

1 SECTION 09 90 00

2 PAINTING

3 PART 1 – GENERAL

4 1.01 SUMMARY

5 A. This section specifies the surface preparation, painting, and finishing of exposed interior
6 and exterior items and surfaces, including previously painted surfaces, where indicated.

7 1. Surface preparation, priming, and finish coats specified in this section are in addition
8 to shop priming and surface treatment specified under other sections.

9 B. Paint exposed surfaces whether or not colors are designated in schedules, except where
10 a surface or material is specifically indicated not to be painted or is to remain natural.
11 Where an item or surface is not specifically mentioned, paint the same as similar adjacent
12 materials or surfaces. If color or finish is not designated, the Engineer will select from
13 standard colors or finishes available.

14 1. Painting includes field painting exposed bare and covered pipes (including color
15 coding), hangers, pipe supports, exposed steel and iron work, and primed metal
16 surfaces of mechanical and electrical equipment.

17 2. Painting also includes the existing concrete wet well after cleaning, sealing, and
18 surface preparation has been performed.

19 C. Painting is not required on prefinished items, finished metal surfaces, concealed surfaces,
20 operating parts, and labels.

21 1. Unless otherwise specified on the Drawings, prefinished items not to be painted
22 include the following factory-finished components:

23 a. Finished mechanical and electrical equipment.

24 b. Light fixtures.

25 c. Switchgear.

26 d. Distribution cabinets.

27 e. Submersible pumps.

28 f. Flowmeters.

29 g. Instrumentation.

30 h. Nameplates.

31 i. Concrete.

32 j. Masonry.

33 D. Finished metal surfaces not to be painted include:

- 1 1. Aluminum.
- 2 2. Stainless steel.
- 3 3. Chromium plate.
- 4 E. Operating parts not to be painted include moving parts of operating equipment such as
- 5 the following:
 - 6 1. Valve and damper operators.
 - 7 2. Linkages.
 - 8 3. Sensing devices.
 - 9 4. Motor, pump, and fan shafts.
- 10 F. Labels: Do not paint over Underwriter's Laboratories, Factory Mutual, or other code required
- 11 labels or equipment name, identification, performance rating, or nomenclature plates.

12 **1.02 SUBMITTALS**

- 13 A. All submittals shall be in accordance with the Specifications unless otherwise noted.
- 14 B. Data Sheets:
 - 15 1. For each paint system furnish Safety Data Sheets (SDS), the manufacturer's Technical
 - 16 Data Sheets, and paint colors available (where applicable) for each product used in
 - 17 the paint system.
 - 18 2. Submit required information on a system-by-system basis.
 - 19 3. Manufacturer's color charts for color selection.
- 20 C. Samples:
 - 21 1. Reference Panel:
 - 22 a. Unless otherwise specified, before painting work is started, prepare minimum
 - 23 8-inch by 10-inch samples with type of paint and application specified on similar
 - 24 substrate to which paint is to be applied. Provide color samples for each color tint
 - 25 for each individual system.
 - 26 b. Furnish additional samples as required until colors, finishes, and textures are
 - 27 approved.
 - 28 c. Approved samples to be the quality standard for final finishes.

- 1 D. Quality Control Submittals:
- 2 1. Applicator's Qualification: Contractor shall provide a list of five references
3 substantiating experience, including current contact names and phone numbers of
4 each reference for verification.
- 5 2. Factory-Applied Coatings:
- 6 a. Manufacturer's certification stating factory-applied coating system meets or
7 exceeds requirements specified.
- 8 b. Current certificate from the coating manufacturer indicating that the applicator is
9 knowledgeable in the product and is qualified to apply the coating system.
- 10 c. Results of Coating Test.
- 11 3. Manufacturer's written instructions and special details for applying each type of paint.

12 **1.03 QUALITY ASSURANCE**

- 13 A. Qualifications:
- 14 1. Applicator: Minimum five years of experience in application of specified products.
- 15 B. Regulatory Requirements:
- 16 1. Meet federal, state, and local requirements limiting the emission of volatile organic
17 compounds.
- 18 2. Perform surface preparation and painting in accordance with recommendations of the
19 following:
- 20 a. Paint manufacturer's instructions.
- 21 b. SSPC-PA Guide No. 3, Guide to Safety in Paint Applications.
- 22 c. Federal, state, and local agencies having jurisdiction.
- 23 C. Single Source Responsibility: Provide primers and undercoat paint produced by the same
24 manufacturer as the finish coats.
- 25 D. Testing of Factory Applied Coating of Ductile Iron Pipe:
- 26 1. The film thickness of the coating shall be checked using a magnetic film thickness.
27 Measurements shall be taken per SSPC PA2 Section 5.1.
- 28 2. The coated areas of the pipe shall be tested for pinholes using a 2000 V pinhole
29 detection test. Any pinholes found shall be repaired prior to shipment.

1 **1.04 DELIVERY, STORAGE, AND HANDLING**

2 A. Deliver materials to the jobsite in the manufacturer’s original, unopened packages and
3 containers bearing manufacturer’s name and label and the following information:

- 4 1. Product name or title of material.
- 5 2. Product description (generic classification or binder type).
- 6 3. Federal specification number, if applicable.
- 7 4. Manufacturer’s stock number and date of manufacture.
- 8 5. Contents by volume, for pigment and vehicle constituents.
- 9 6. Thinning instructions.
- 10 7. Application instructions.
- 11 8. Color name and number.
- 12 9. SDS, Safety Data Sheets, for all coatings and thinners.

13 B. Store materials not in use in tightly covered containers in a well-ventilated area at an
14 ambient temperature greater than the minimum temperature recommended by the
15 manufacturer. Maintain containers used in storage in a clean condition, free of foreign
16 materials and residue:

- 17 1. Protect materials from freezing. Keep storage area neat and orderly. Remove oily rags
18 and waste daily. Take necessary measures to ensure that workers and work areas are
19 protected from fire and health hazards resulting from handling, mixing, and application.

20 **1.05 JOB CONDITIONS**

21 A. Apply water-based paints only when the temperature of surfaces to be painted and
22 surrounding air temperatures are between 50°F and 90°F, unless otherwise recommended
23 by the paint manufacturer.

24 B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and
25 surrounding air temperatures are between 45°F (7°C) and 95°F (35°C).

26 C. Do not apply paint in snow, rain, fog, or mist when the relative humidity exceeds 85%, at
27 temperatures less than 5°F above the dew point unless specifically allowed by the paint
28 manufacturer, or to damp or wet surfaces:

- 29 1. Painting may continue during inclement weather if surfaces and areas to be painted
30 are enclosed and heated within temperature and humidity limits specified by the
31 manufacturer during application and drying periods.

1 **PART 2 – PRODUCTS**

2 **2.01 MANUFACTURERS**

3 A. Available Manufacturers:

4 1. Subject to compliance with requirements, provide paint system products from the
5 following paint manufacturers for this project:

6 a. Wasser Corporation (Wasser).

7 b. Tnemec Company, Inc. (Tnemec).

8 c. The Sherwin-Williams Company (Sherwin-Williams).

9 d. PPG Industries, Inc. (PPG).

10 **2.02 PAINT MATERIALS, GENERAL**

11 A. Material Compatibility: Provide primers, finish-coat materials, and related materials that
12 are compatible with one another and the substrates indicated under conditions of service
13 and application as demonstrated by the manufacturer based on testing and field
14 experience.

15 B. Material Quality: Provide the manufacturer's best-quality trade-sale paint material of the
16 various coating types specified. Paint-material containers not displaying manufacturer's
17 product identification will not be acceptable.

18 C. Proprietary Names: Use of manufacturer's proprietary product names to designate colors
19 or materials is not intended to imply that products named are required to be used to the
20 exclusion of equivalent products of other manufacturers. Furnish the manufacturer's
21 material data and certificates of performance for proposed substitutions.

22 D. Colors: Provide color selections made by the Engineer from the manufacturer's full range
23 of standard colors.

24 **PART 3 – EXECUTION**

25 **3.01 EXAMINATION**

26 A. Examine substrates and conditions under which painting will be performed for compliance
27 with paint application requirements. Surfaces receiving paint must be thoroughly dry
28 before paint is applied:

29 1. Do not begin to apply paint until unsatisfactory conditions have been corrected.

30 2. Start of painting will be construed as the applicator's acceptance of surfaces and
31 conditions within a particular area.

- 1 B. Coordination of Work:
- 2 1. Review other sections in which primers are provided to ensure compatibility of the total
3 system for various substrates. On request, furnish information on characteristics of
4 finish materials to ensure use of compatible primers.
- 5 2. Notify the Engineer about anticipated problems using the materials specified over
6 substrates primed by others, or over existing coated surfaces that are to be prepared
7 and recoated.

8 **3.02 PREPARATION**

- 9 A. General: Remove hardware and hardware accessories, plates, machined surfaces,
10 lighting fixtures, and similar items already installed that are not to be painted, or provide
11 surface-applied protection prior to surface preparation and painting. Remove these items,
12 if necessary, to completely paint the items and adjacent surfaces. Following completion of
13 painting operations in each space or area, have items reinstalled by workers skilled in the
14 trades involved.
- 15 B. Cleaning: Before applying paint or other surface treatments, clean the substrates of
16 substances that could impair the bond of the various coatings with a quality bio-degradable
17 cleaner and thoroughly rinse with clean water. Allow for complete drying of substrate to be
18 painted. Remove all oil and grease prior to cleaning. Schedule cleaning and painting so
19 that dust and other contaminants from the cleaning process will not fall on wet, newly
20 painted surfaces.
- 21 C. Surface Preparation:
- 22 1. Clean and prepare surfaces to be painted according to the manufacturer's instructions
23 for each particular substrate condition and as specified.
- 24 2. Provide barrier coats over incompatible primers and existing coatings or remove and
25 redo. Notify Engineer in writing about anticipated problems using the specified finish
26 coat material with substrates primed by others.
- 27 3. Cementitious Materials: Prepare concrete and concrete masonry unit surfaces to be
28 painted. Remove efflorescence, chalk, dust, dirt, grease, oils, release agents, and
29 existing unsound coatings. Roughen as required to remove glaze. If hardeners or
30 sealers have been used during curing, use mechanical methods of surface
31 preparation:
- 32 a. Use abrasive blast cleaning methods if recommended by paint manufacturer.
- 33 b. Determine alkalinity and moisture content of surfaces by performing appropriate
34 tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and
35 burn, correct this condition prior to paint application. Do not paint surfaces where
36 moisture content exceeds that permitted in manufacturer's written instructions.

- 1 4. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral
2 spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust
3 off:
- 4 a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac
5 or other recommended knot sealer before applying primer. After priming, fill holes
6 and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth
7 when dried.
- 8 5. Ferrous Metals:
- 9 a. Clean un-galvanized ferrous-metal surfaces that have not been shop-coated and
10 previously painted metals indicated for painting; remove oil, grease, dirt, loose mill
11 scale, and other foreign substances. Perform abrasive blast cleaning methods if
12 recommended by paint manufacturer or as specified. Use solvent or mechanical
13 cleaning methods that comply with recommendations of the formerly named Steel
14 Structures Painting Council (SSPC), now called The Society of Protective
15 Coatings.
- 16 b. Touch up bare areas and shop-applied prime coats that have been damaged. Wire
17 brush, clean with solvents recommended by the paint manufacturer, and touch up
18 with the same primer as the shop coat.
- 19 6. Galvanized Surfaces:
- 20 a. Clean galvanized surfaces with nonpetroleum-based solvents so that the surface
21 is free of all oil and surface contaminants.
- 22 b. Remove pretreatment from galvanized sheet metal fabricated from coil stock by
23 mechanical methods.
- 24 7. PVC Pipe:
- 25 a. Prepare PVC surfaces in accordance with manufacturer's instructions.
- 26 b. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other
27 contaminants.
- 28 c. Scarify PVC surfaces to impart a profile and remove all loose particles.
- 29 8. Ductile Iron Pipe:
- 30 a. Prepare ductile or cast iron surfaces in accordance with manufacturers'
31 instructions.
- 32 b. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other
33 contaminants. Provide solvent cleaning per National Association of Pipe
34 Fabricators Standard NAPF 500-03-01. Also, blast all Ductile Iron Pipe in
35 accordance with NAPF 500-03-04/05.

- 1 D. Materials Preparation:
- 2 1. Carefully mix and prepare paint materials according to manufacturer's directions.
- 3 2. Maintain containers used in mixing and applying paint in a clean condition, free of
4 foreign materials and residue.
- 5 3. Stir material before application to produce a mixture of uniform density; stir as required
6 during application. Do not stir surface film into material. Remove film and, if necessary,
7 strain material before using.
- 8 4. Use only thinners approved by the paint manufacturer and only within recommended
9 limits.
- 10 E. Tinting:
- 11 1. Tint each undercoat a lighter shade to facilitate identification of each coat where
12 multiple coats of the same material are applied.
- 13 2. Tint undercoats to match the color of the finish coat, but provide sufficient differences
14 in shade of undercoats to distinguish each separate coat.

15 **3.03 FIELD APPLICATION**

- 16 A. General:
- 17 1. Apply paint according to manufacturer's directions. Use applicators and techniques
18 best suited for substrate and type of material being applied.
- 19 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions
20 detrimental to formation of a durable paint film.
- 21 3. Provide finish coats that are compatible with primers used.
- 22 4. The number of coats and the film thickness required are the same regardless of the
23 application method. Do not apply succeeding coats until the previous coat has cured
24 as recommended by the manufacturer. Sand between applications where sanding is
25 required to produce a smooth, even surface according to the manufacturer's
26 directions.
- 27 5. Apply additional coats if undercoats, stains, or other conditions show through final coat
28 of paint until paint film is of uniform finish, color, and appearance. Give special attention
29 to ensure that surfaces, including edges, corners, crevices, welds, and exposed
30 fasteners, receive a dry film thickness equivalent to that of flat surfaces.
- 31 6. The term "exposed surfaces" includes areas visible when permanent or built-in
32 fixtures, convactor covers, covers for finned-tube radiation, grilles, and similar
33 components are in place. Extend coatings in these areas, as required, to maintain the
34 system integrity and provide desired protection.

1 7. Paint surfaces behind movable equipment the same as similar exposed surfaces.
2 Before the final installation of equipment, paint surfaces behind permanently fixed
3 equipment with prime coat only.

4 8. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat,
5 non-specular acrylic latex black paint.

6 B. Scheduling Painting:

7 1. Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared
8 for painting as soon as practicable after preparation and before subsequent surface
9 deterioration.

10 2. Allow sufficient time between successive coats to permit proper drying. Do not recoat
11 until paint has dried to where it feels firm, does not deform or feel sticky under
12 moderate thumb pressure, and where application of another coat of paint does not
13 cause the undercoat to lift or lose adhesion.

14 C. Application Procedures:

15 1. Apply paints and coatings by brush, roller, spray, or other applicators according to the
16 manufacturer's directions:

17 a. Brushes: Use brushes best suited for the material applied.

18 b. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as
19 recommended by the manufacturer for the material and texture required.

20 c. Spray Equipment: Use airless spray equipment with orifice size as recommended
21 by the manufacturer for the material and texture required.

22 D. Minimum Coating Thickness: Apply materials no thinner than the manufacturer's
23 recommended spreading rate. Provide the total dry film thickness of the entire system as
24 recommended by the manufacturer and as specified, whichever is greater.

25 E. Electrical items to be painted include, but are not limited to, the following:

26 1. Exposed conduit and fittings in occupied spaces.

27 2. Motors provided without factory-applied coatings.

28 F. Prime Coats:

29 1. Before applying finish coats, apply a prime coat of material, as recommended by the
30 manufacturer, to material that is required to be painted or finished and that has not
31 been prime-coated by others.

32 2. Recoat primed and sealed surfaces where evidence of suction spots or unsealed
33 areas in first coat appears, to ensure a finish coat with no burn-through or other defects
34 due to insufficient sealing.

1 G. Pigmented (Opaque) Finishes: Completely cover to provide a smooth, opaque surface of
2 uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps,
3 brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

4 H. Completed Work:

5 1. Match approved samples for color, texture, and coverage.

6 2. Remove, refinish, or repaint work not complying with specified requirements.

7 **3.04 FACTORY COATED DUCTILE IRON PIPE**

8 A. Jobsite Repair: Any areas where damage has occurred due to handling shall be repaired
9 using a touch-up kit provided by the coating manufacturer prior to installation to equal the
10 original coating.

11 B. Handling: All pipes shall be handled with belt slings and padded forks to avoid damage.
12 All shipping timbers and straps shall be padded when shipping pipe.

13 C. Pipe Condition: All pipe shall be delivered to the coating applicator bare.

14 D. Surface Preparation: The entire surface to be coated shall be abrasive blasted.

15 E. Coating of Pipe: After surface preparation and within 8 hours of surface preparation. If any
16 rusting is apparent prior to coating the surface, the entire area must be re-blasted.

17 **3.05 CLEANING**

18 A. Cleanup:

19 1. At the end of each workday, remove empty cans, rags, rubbish, and other discarded
20 paint materials from the site.

21 2. After completing painting, clean glass and paint-spattered surfaces. Remove spattered
22 paint by washing and scraping. Do not scratch or damage adjacent finished surfaces.

23 **3.06 PROTECTION**

24 A. Protect work of other trades, whether being painted or not, against damage by painting.
25 Protect adjacent walls, floors, and ceilings against splash and overspray. Correct damage
26 by cleaning, repairing or replacing, and repainting. The Contractor shall be solely
27 responsible for costs to repair damages to Owner's property or private property due to
28 splash and overspray.

29 B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective
30 wrappings provided by others to protect their work after completing painting operations.

31 C. At completion of construction activities of other trades, touch up and restore damaged or
32 defaced painted surfaces.

1 **3.07 PAINT SCHEDULE**

2 A. General: Provide the following paint systems for the various substrates indicated.
3 Spreading rate and dry film thickness of each coat of paint (i.e., primer and finish coat)
4 shall be in accordance with the paint manufacturer's requirements. Unless otherwise
5 specified, the following definitions shall apply to the paint systems specified below:

- 6 1. Interior: Surfaces located inside of a building, protected from weather elements.
7 2. Exterior: Equipment and piping surfaces located outside and exposed to weather
8 elements or inside of below-grade vaults and other below-grade, unconditioned
9 structures.
10 3. Immersed: All piping surfaces located inside manholes or wet wells.

11 B. Interior and Exterior Zinc-Coated Metal: Provide the following paint systems, consisting of
12 two finish coats applied over a galvanized metal primer, over all exposed zinc-coated
13 (galvanized) metal piping and equipment surfaces:

14 1. Surface Preparation: For existing surfaces, power tool cleaning per SSPC SP-3. For
15 new galvanized surfaces, solvent cleaning per SSPC SP-1.

16 2. Primer:

- 17 a. Tnemec: Series 115 Unibond.
18 b. Sherwin-Williams: Galvite HS B50WZ30.
19 c. Wasser: MC-Universal Primer 100.

20 3. First and Second Finish Coats: Shall be full-gloss, exterior, alkyd enamel:

- 21 a. Tnemec: Series 1029 Enduratone.
22 b. Sherwin-Williams: Industrial Alkyd Urethane Enamel B54-150 Series.
23 c. Wasser: MC-Luster 100.

24 C. Interior and Exterior Ferrous Metal, Piping, and Valves: Provide the following paint system,
25 consisting of one rust-inhibiting primer and two finish coats. Bolts and nuts shall not be
26 coated. Valve Vault piping and valves shall be factory coated and shall not be field coated:

27 1. Surface Preparation: Shall be performed in accordance with NAPF 500 03-04/05 and
28 paint manufacturer's recommendations.

29 2. Primer: Polyamide Rust Inhibitive Direct to Metal Epoxy.

- 30 a. Tnemec: Series 161 Epoxoline.
31 b. Sherwin-Williams: Macropoxy 646 FC B58-600 Series.
32 c. Wasser: MC-Ferroclad 100.

- 1 3. First Finish Coat: Polyamide Epoxy.
- 2 a. Tnemec: Series 161 Epoxoline.
- 3 b. Sherwin-Williams: Macropoxy 646 FC B58-600 Series.
- 4 c. Wasser: MC-Luster 100.
- 5 4. Second Finish Coat: Acrylic, Aliphatic Polyurethane.
- 6 a. Tnemec: Series 73 EnduraShield.
- 7 b. Sherwin-Williams: Acrolon 218 HS B65-650 Series.
- 8 c. Wasser: MC-Luster 1000.
- 9 D. Immersed Ductile Iron Pipe: Provide the factory applied paint system below on the exterior
10 surfaces of the ductile iron piping located inside the Wet Well. Paint system shall consist
11 of a single coat applied over bare ductile iron pipe.
- 12 1. Surface Preparation: Shall be as directed by the coating manufacturer.
- 13 2. Coating: Coating shall be applied an average of 25 mils (20 mils minimum) over the
14 entire pipe spool.
- 15 a. Induron: Ceramawrap Epoxy.
- 16 b. Or equal.
- 17 E. Concrete Wet Well and Vaults: Provide the following finish systems for the concrete vault
18 surfaces. Concrete surfaces shall be allowed to age for at least 28 days and allowed to
19 dry to the moisture content recommended by the coating manufacturer. Temperature of
20 the surface to be coated shall be between 40°F to 120°F. Contractor shall follow all
21 manufacturers' installation procedures:
- 22 1. Exterior coating shall be bituminous waterproof coating material.

23 3.08 COLORS

- 24 A. Pipe Identification Painting:
- 25 1. Color code all piping except electrical conduit and stainless steel piping. Paint all PVC
26 and metallic fittings and valves the same color as the adjoining piping.
- 27 2. Piping Color Coding: As shown in Table 09 90 00-1.
- 28 3. Pipe Supports: Color of all pipe supports shall be No. 70 light gray as specified in
29 ANSI 359-A-85.
- 30 B. Colors: Provide as designated herein and as selected by Owner or Engineer. Remaining
31 colors to be determined by Engineer during submittal review.

1 C. Proprietary identification of colors is for identification only. Selected manufacturer may
2 supply matching colors upon acceptance by the Engineer.

3 D. Equipment Colors:

4 1. Equipment includes the machinery or vessel itself plus the structural supports and
5 fasteners and attached electrical conduits.

6 2. Paint equipment and piping one color as selected.

7 3. Paint equipment the same color as the piping it serves, except as itemized below:

8 a. Dangerous Parts of Equipment and Machinery: OSHA Orange.

9 b. Fire Protection Equipment and Apparatus: OSHA Red.

10 c. Physical Hazards in Normal Operating Area and Energy Lockout Devices: OSHA
11 Yellow.

12 d. Safety Equipment, Including, but Not Limited to, Eyewashes and Safety Showers:
13 OSHA Green.

14 E. Fiberglass reinforced plastic (FRP) grating and ductwork with an integral colored gel coat
15 does not require painting, provided the color is as selected by the Owner.

16 **Table 09 90 00-1. Pipe Service Color Codes**

Pipe Service	Color
Drain	Black
Sanitary Sewer	Black
Vent	Black

17 **END OF SECTION**

1

2

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3

1 **SECTION 13 05 41**

2 **SEISMIC RESTRAINT REQUIREMENTS FOR NONSTRUCTURAL COMPONENTS**

3 **PART 1 – GENERAL**

4 **1.01 SUMMARY**

- 5 A. This section specifies the anchorage and bracing for equipment and seismic anchoring
6 and bracing for suspended equipment and equipment over 200 pounds.

7 **1.02 QUALITY ASSURANCE**

- 8 A. Reference Standards: This section incorporates by reference the latest revisions of the
9 following documents. These documents are a part of this section as specified and
10 modified. In case of conflict between the requirements of this section and those of the
11 listed documents, the requirements of this section shall prevail.

12 **Reference**

Title

13 IBC 2021

International Building Code

14 ASCE/SEI 7-16

Minimum Design Loads for Buildings and Other Structures

15 **1.03 SUBMITTALS**

- 16 A. Provide submittal data per Section 01 33 00, "Submittal Procedures."
17
18 B. List of freestanding equipment weighing 200 pounds or more.
19
20 C. Anchorage details for equipment and freestanding items weighing between 200 and
21 400 pounds.
22
23 D. No less than 4 weeks in advance of equipment installation, for items weighing over
24 400 pounds. Required anchorage and bracing drawings and calculations bearing the stamp
25 of a Professional Engineer; show the criteria used to determine seismic coefficients and forces
26 applied to the equipment, including seismic zone, soil profile type, and importance factors.
27
28

24 **1.04 DESIGN AND PERFORMANCE REQUIREMENTS**

- 25 A. In accordance with IBC, all equipment shall be anchored and braced to resist seismic
26 forces prescribed in the code and ASCE/SEI 7, Chapter 13 or 15. All equipment includes
27 equipment which is free standing, supported by stand frames, suspended, anchored to
28 walls, and anchored to floors or slabs.
29
30 B. Seismic anchorage and bracing for equipment shall be designed by a State of Washington
Registered Engineer using the site-specific seismic criteria.

1 **1.05 SITE SEISMIC CRITERIA**

2 A. Short Periods, $S_d = 0.976$.

3 B. Importance Factor, $I_p = 1.5$.

4 C. Site Class = D.

5 D. Risk Category: III.

6 E. Seismic Design Category: D.

7 F. Response Modification Coefficient and Amplification Factors: In accordance with ASCE/
8 SEI 7-16 Sections 13.5 or 13.6.

9 **PART 2 – PRODUCTS**

10 **2.01 ANCHORAGE TO CONCRETE**

11 A. Post-installed expansion or adhesive anchors are allowed only if, based upon the current
12 ICC Evaluation Service Report, the anchors are permitted to be used for seismic loads.

13 B. Cable or wire bracing is not allowed, except for suspended ceilings.

14 **PART 3 – EXECUTION (NOT USED)**

15 **END OF SECTION**

1 **SECTION 22 05 00**

2 **GENERAL REQUIREMENTS FOR PIPING**

3 **PART 1 – GENERAL**

4 **1.01 DESCRIPTION**

- 5 A. This section specifies the general requirements for piping systems. Additional information
6 regarding material requirements, installation, etc. can be found in the individual piping
7 sections. The actual pipe size and fittings shall be as shown on the Drawings, and
8 described in the Pipe Schedule.
- 9 B. This specification section applies to the sewer facilities associated with this project.
- 10 C. Provide required permits, inspections, labor project equipment and materials, tools,
11 construction equipment, transportation, and test equipment, and satisfactorily complete
12 piping work shown on the Drawings. In addition, provide complete mechanical installation
13 including piping, supporting, and anchoring for the equipment that will be provided under
14 divisions of these Specifications for a complete working system.
- 15 D. Piping designations (indicating the nominal pipe size and individual piping system) are used
16 throughout the pump station drawings. Note that in most cases, the piping system material
17 is not included below the piping designation on the drawings. Rather, the pipe material for
18 each corresponding piping system is identified in the piping schedule contained in Section
19 22 06 00, "Pipe Schedule." Contractor shall be responsible for matching up the piping
20 system designations shown on the drawings with the corresponding pipe materials listed in
21 the "Pipe Schedule" to determine which piping materials are to be installed for this project.

22 **1.02 SUBMITTALS**

- 23 A. Shop Drawings and Product Data:
- 24 1. Provide submittal data per Section 01 33 00, "Submittal Procedures."
- 25 2. Submit product review or product information Shop Drawings for materials and equipment
26 as required under each specification section in accordance with the Specifications.
- 27 3. For product review submittals, submit a single, complete submittal package for items
28 specified for each specification section of CSI Division 22. Submittal packages shall
29 be organized by service type. Include separators and tabs or other means of identifying
30 each section and specification paragraph of the submittal.
- 31 4. Provide piping layout drawings showing the locations, lengths, and elevations for all
32 piping systems (exposed, buried, and submerged) in that area with respect to
33 structures, other piping, and utilities (ductwork, conduit, etc.) drawings shall contain
34 details and location of all joints, anchors, supports, fittings, connections, penetrations,
35 valves, piping appurtenances, flexible couplings, manholes, and other items as
36 required. Deviations from anchorage requirements in accordance with the
37 Specifications shall be specified and supported with anchorage calculations.

- 1 5. For each piping system identified in the Pipe Schedule, submit pipe, fittings, linings,
2 and coatings to be used for each piping system specified.
- 3 6. Manufacturer's handling, delivery, storage, and installation instructions.
- 4 7. Pipeline layout showing stations and elevations.
- 5 8. Welder certifications and qualifications.
- 6 9. Details of stulling and shipping packaging.
- 7 10. Pipe is to be furnished with special lengths, field-trim pieces, and closure pieces as
8 required by Plans and sections for location of elbows, tees, reducers, valves, and other
9 in-line fittings. The pipe fabricator shall prepare a pipe laying schedule showing the
10 location of each piece by mark number with station and invert elevation at each end.
- 11 B. Leakage Testing Report Documentation: After testing of each piping segment has been
12 completed, submit the following in accordance with the CSI Division 1:
 - 13 1. Actual test date.
 - 14 2. Description and identification of piping segment tested.
 - 15 3. Testing fluid/medium used.
 - 16 4. Actual test pressure.
 - 17 5. Remarks, including:
 - 18 a. Leaks (type, location).
 - 19 b. Repair/replacement performed to remedy excessive leakage.
 - 20 6. All test report documentation shall be signed by the Contractor to represent that the
21 testing has been satisfactorily completed.
- 22 C. Record Drawings: Prior to Final Acceptance, deliver one complete set to the Engineer for
23 review. Final Acceptance will not be granted until favorable review is completed:
 - 24 1. Submittal Drawings: Revise manufacturers shop drawings to show any construction
25 changes.
 - 26 2. Contract Drawings: Provide contract record drawings in accordance with the
27 Specifications.
- 28 D. Quality Control Submittals:
 - 29 1. Certified welding inspection and test results.
 - 30 2. A copy of the surveyor's notes for the newly installed pipe and appurtenances.

- 1 3. Pipe Leakage Testing Plan:
- 2 a. Submit prior to testing and include at least the information that follows:
- 3 1) Testing dates.
- 4 2) Piping systems and section(s) to be tested.
- 5 3) Test type, pressure, and duration.
- 6 4) Method of isolation.
- 7 5) Calculation of maximum allowable leakage for piping section(s) to be tested.
- 8 b. Certifications of Calibration: Testing equipment.
- 9 c. Certified Test Report:
- 10 1) Actual test date.
- 11 2) Description and identification of piping segment tested.
- 12 3) Testing fluid/medium used.
- 13 4) Actual test pressure.
- 14 5) Remarks, including:
- 15 a) Leaks (type, location).
- 16 b) Repair/replacement performed to remedy excessive leakage.
- 17 6) All test report documentation shall be signed by the Contractor to represent
- 18 that the testing has been satisfactorily completed.

19 **1.03 HANDLING, STORAGE, AND SHIPPING**

- 20 A. Pipe shall be stulled as required to maintain roundness of plus or minus 1% during
- 21 shipping and handling.
- 22 B. Coated pipe shall be shipped on padded bunks with nylon belt tie-down straps or padded
- 23 banding located approximately over stulling.
- 24 C. Coated pipe shall be stored on padded skids, sand or dirt berms, sandbags, old tires, or
- 25 other suitable means so that coating will not be damaged.
- 26 D. Coated pipe shall be handled with wide belt slings. Chains, cables, or other equipment
- 27 likely to cause damage to the pipe or coating shall not be used.

1 **1.04 PIPING SYSTEMS**

2 A. General:

- 3 1. Furnish and install pipe, specials, fittings, closure pieces, supports, bolts, nuts,
4 gaskets, jointing materials, and appurtenances as shown and specified, and as
5 required for a complete and functioning piping system. All pressure pipe joints shall be
6 restrained. Stainless steel pipe shall have full circumferential welds.
- 7 2. All exposed piping shall be adequately supported and restrained with devices of
8 appropriate design and as specified in Section 22 05 29, "Pipe Hangers and Supports."
9 Where details are shown, the supports shall conform thereto and shall be placed as
10 indicated, provided that support for all piping shall be complete and adequate
11 regardless of whether or not supporting devices are specifically shown.
- 12 3. Lined and coated pipe shall be stored in such a manner that the lining and coating will
13 not crack or otherwise be damaged due to the effects of freezing and thawing, sunlight,
14 and dry weather conditions.
- 15 4. All Materials delivered to the jobsite shall be new, free from defects, and marked to
16 identify the material, class, and other appropriate data, such as thickness for piping.
- 17 5. Acceptance of materials shall be subject to strength and quality testing in addition to
18 inspection of the complete product. Acceptance of installed piping systems shall be
19 based on inspection and leakage tests.
- 20 6. All valves and operators of the same type shall be by a single manufacturer.

21 B. Pipe Laying:

- 22 1. Both line and grade shall be checked using survey instruments and recorded in a field
23 book for each piece of pipe and appurtenances laid. The Contractor shall have
24 instruments such as transits, levels, laser devices, and other equipment for
25 transferring alignment and grades from offset hubs. Contractor also shall employ a
26 person who is qualified to use such instruments and who shall be on the job site at all
27 times when pipe is being installed and shall have the responsibility of placing and
28 maintaining such construction guides. The Contractor shall furnish to the Engineer a
29 copy of the surveyor's notes for the newly installed pipe and appurtenances.
- 30 2. At a sufficient distance prior to encountering a known obstacle or tie into an existing
31 pipe, expose and verify the exact location of the obstacle or pipe so that proper
32 alignment and grade may be determined before the pipe sections are laid in the trench
33 and backfilled.
- 34 3. Pipe laid on grades of 10% or greater shall be installed beginning at the bottom of the
35 slope.

- 1 4. Maintain the pipeline free of standing water at all times during construction prior to
2 filling the pipeline for testing.
- 3 5. Bends and tees in buried pressure piping systems shall be anchored by means of
4 restrained joints. Restrained joint length shall be as required for the test pressure
5 shown in the piping system. Submit calculations showing the type of restrained joint
6 proposed and the length of restrained joint required. Concrete thrust blocks shall not
7 be used unless specifically shown.
- 8 C. Pipe Installation:
- 9 1. All pipe penetrations through reinforced concrete structures shall be constructed to
10 prevent metal-to-metal contact between the pipe and reinforcing steel in the wall. Care
11 shall be exercised to avoid bypassing insulating flanges with cable, piping, or other
12 metallic objects.
- 13 2. Equipment shall be positioned and aligned so that no strain shall be induced within the
14 equipment during or subsequent to the installation of piping.
- 15 3. When temporary supports are used, they shall be sufficiently rigid to prevent any
16 shifting or distortion of the piping or related work.
- 17 4. Takedown couplings shall be installed where shown on the Drawings and at such other
18 points as may be required for ease of installation or removal of the pipe, subject to
19 approval of the Engineer. Takedown couplings shall be of the positive lock type where
20 necessary to prevent separation of pipe due to internal pressure.

21 PART 2 – PRODUCTS

22 2.01 PIPING SYSTEMS AND CORRESPONDING PIPE MATERIALS

- 23 A. As specified on Pipe Schedule located at the end of this section and other sections of CSI
24 Division 22.

25 2.02 JOINTS

- 26 A. Grooved End System:

- 27 1. Grooved pipe and groove joints shall be in accordance with AWWA C606. All grooved
28 ductile iron piping shall be furnished with rigid radius grooves, unless otherwise shown
29 on the Drawings.
- 30 2. Grooved Piping Accessories:
- 31 a. Grooved Coupling: Shall be used to connect ductile iron pipe grooved-ends together.
- 32 b. Grooved Flanged Adapter: Shall be used to connect ductile iron pipe grooved-end
33 to a 125# flanged connection. When required, furnish with grooved-type flange
34 adapters of same manufacturer as grooved end couplings.
- 35 c. Transition Fittings: Shall be used to connect grooved-ends of dissimilar materials.

- 1 3. Acceptable Manufacturers:
- 2 a. Victaulic.
- 3 b. Anvil International.
- 4 c. Grinnell.
- 5 d. Or approved equal.
- 6 B. Flanged Joints:
- 7 1. Flat-faced carbon steel or alloy flanges when mating with flat-faced cast or ductile iron
- 8 flanges conforming to AWWA C115-11. Bolt circle and bolt holes shall match those of
- 9 ANSI B16.1, Class 125 flanges and ANSI B16.5, Class 150 flanges.
- 10 2. Higher pressure rated flanges as required to mate with equipment when equipment
- 11 flange is of higher pressure rating than required for piping.
- 12 C. Threaded Joints: NPT taper pipe threads in accordance with ANSI B1.20.1.
- 13 D. Mechanical Joint Anchor Gland Follower:
- 14 1. Ductile iron anchor type, wedge action, with break-off tightening bolts. Fittings shall
- 15 conform to AWWA/ANSI C110/A21.10. Mechanical properties shall conform to
- 16 AWWA/ANSI C151/A21.51.
- 17 E. Proprietary Restrained:
- 18 1. Restrained mechanical joint couplings shall be ROMAGRIP by Romac Industries Inc.
- 19 2. Flanged coupling adapters shall be RFCA by Romac Industries Inc.
- 20 F. Push-On and Proprietary Restrained: Shall conform to AWWA C110/A21.10 and
- 21 C111/A21.11. Restrained Joints shall be designed for a working pressure of 350 psi for
- 22 sizes 4-inch through 24-inch, and 250 psi for sizes 30-inch through 36-inch.
- 23 G. Flexible Mechanical Compression Joint Coupling for Drains and Gravity Piping:
- 24 1. Stainless steel, ASTM A276, Type 305 bands.
- 25 H. Thrust Tie-Rod Assemblies:
- 26 1. NFPA 24; tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust
- 27 are unacceptable.
- 28 2. For welded steel pipe, design per AWWA M11 based on test pressure of the pipe.
- 29 I. All fittings shall be lined and coated to match pipe.

1 **2.03 VALVES**

- 2 A. All valves shall be furnished complete with all necessary geared actuators, handwheels,
3 levers, valve bonnets, valve boxes, extension stems, operating nuts, and T handle
4 wrenches, which are required for proper valve operation. All operators, actuators, and
5 accessories shall be factory-mounted prior to shipping to the project site. Renewable parts
6 including discs, packing, and seats shall be of types specified herein and acceptable by
7 valve manufacturer for the intended service. All units shall have the name of the
8 manufacturer and the size of the valve cast on the body or bonnet, or shown on a
9 permanently attached stainless steel plate in raised embossed letters. All isolation valves
10 shall be suitable for the intended service with bubble tight shutoff to flow in either direction.
- 11 B. All valves shall be the same size and all valve ends shall be the same type as the adjoining
12 pipe unless noted otherwise in the Drawings.
- 13 C. All valves shall open by turning the operator counterclockwise.
- 14 D. All non-elastomeric valves and valve operators shall be factory prepared and primed, and
15 field finish coated in accordance with Section 09 90 00, "Painting." Color shall match the
16 adjoining piping.
- 17 E. All valves of the same type shall be from one manufacturer.
- 18 F. Manual Operators:
- 19 1. General: Unless otherwise indicated, provide operators as shown on the Drawings:
- 20 a. Operator force not to exceed 80 pounds under any operating condition, including
21 initial breakaway. Gear reduction operator when force exceeds 80 pounds.
- 22 b. Operator self-locking type or equipped with self-locking device.
- 23 c. Position indicator on quarter-turn valves.
- 24 d. Worm and Gear Operators: One-piece design worm gears of gear bronze material.
25 Worm-hardened alloy steel with thread ground and polished. Traveling nut type
26 operators, threaded steel reach rods with internally threaded bronze or ductile iron nut.
- 27 2. Exposed Operator:
- 28 a. Galvanized and painted handwheels.
- 29 b. Cranks on gear type operators.
- 30 3. Buried Operator:
- 31 a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch
32 AWWA operating nut. Buried operators on valves 2 inches and smaller shall have
33 cross handle for operation by forked key. Enclose moving parts of valve and
34 operator in housing to prevent contact with the soil.

1 b. Design buried service operators for quarter-turn valves to withstand 450 foot pounds
2 of input torque at the FULLY OPEN or FULLY CLOSED positions, grease packed
3 and gasketed to withstand a submersion in water to 10 psi.

4 c. Buried valves shall be furnished with extension stems, bonnets, and valve boxes.

5 G. Valve Boxes:

6 1. Valve boxes shall be cast iron two-piece slip-type standard design with a base
7 corresponding to the size of the valve, coal tar painted with manufacturer's standard.
8 Distribution system valve boxes shall include cast iron ring and pentagon bolt locking
9 cast iron cover labeled "SEWER" for sanitary sewer valves, and "WATER" for water
10 distribution valves.

11 2. 6-inch- and 10-inch-diameter valve boxes shall be per WSDOT Standard Specification
12 Section 9-15.5.

13 3. Underground enclosures for valves assemblies shall be polymer concrete with open
14 base. Size shall be sufficient to allow access to valves and assemblies for repair and/or
15 removal without removing enclosure. Enclosures shall have Tier 22 load rated bolt
16 down cover. Enclosures shall be as manufactured by "Synertech" or approved
17 equivalent.

18 **2.04 BOLTS AND NUTS**

19 A. Threads: ANSI B1.1 coarse thread series, Class 2A external and Class 2B internal.

20 B. Length: In conformance with ANSI B16.5.

21 C. Materials:

22 1. Buried and Exposed in Vaults: AISI Type 304 Stainless Steel – In conformance with
23 ASTM A193 and ASTM A194 Grade B8 Class 2, marking B8.

24 2. Inside Wet Well: AISI Type 316 Stainless Steel – In conformance with ASTM F593 and
25 ASTM F594 alloy group 2, markings F593F and F594F.

26 3. Inside Buildings and Outside Exposed: Galvanized Steel – In conformance with
27 ASTM A307, Grade B, 60,000 PSI minimum tensile strength, markings 307B. Hot dip
28 galvanized per ASTM A153 after fabrication.

29 D. Nuts and bolts, and gaskets for flanged fittings and blind flanges, shall be designed to
30 withstand the design and test pressure rating for the pipe.

31 **2.05 GASKET LUBRICANT**

32 A. All lubricant shall be supplied by pipe manufacturer.

33 **2.06 FABRICATION**

34 A. Mark each pipe length on outside:

- 1 1. Size or diameter and class.
- 2 2. Manufacturer's identification and pipe serial number.
- 3 3. Location number on laying Drawing.
- 4 4. Date of manufacture.
- 5 B. Code markings according to approved shop drawings.
- 6 C. Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the site with
- 7 flanges in place and properly faced. Threaded flanges shall be individually fitted and
- 8 machine tightened on matching threaded pipe by the manufacturer.

9 **2.07 PIPE SLEEVES**

10 A. Steel Pipe Sleeve:

- 11 1. Minimum Thickness: 3/16 inch.
- 12 2. Seep Ring:
 - 13 a. 3/16 inch minimum thickness center steel flange for water stoppage on sleeves in
 - 14 exterior or water-bearing walls.
 - 15 b. Outside Diameter: 3 inches greater than pipe sleeve outside diameter.
 - 16 c. Continuously fillet weld on each side all around.
- 17 3. Factory Finish:
 - 18 a. Galvanizing:
 - 19 1) Hot-dip applied, meeting requirements of ASTM A153.
 - 20 2) Electroplated zinc or cadmium plating is unacceptable.

21 B. Plastic Pipe Sleeve:

- 22 1. High density polyethylene.
- 23 2. Integrally Formed Water Stop: 4 inches larger than sleeve outside diameter, minimum.
- 24 3. Installation end caps to attach to concrete forms to locate sleeve and to prevent
- 25 deformation of sleeve during concrete pour.
- 26 4. Manufacturers and Products:
 - 27 a. Thunderline Link-Seal; CenturyLine Sleeves.
 - 28 b. Or equal.

- 1 C. Modular Mechanical Seal:
- 2 1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill
3 annular space between pipe and wall sleeve opening.
- 4 2. Fabrication: Assemble interconnected rubber links with ASTM A276, Type 316 stainless
5 steel bolts, nuts, and pressure plates.
- 6 3. Size: According to manufacturer's instructions for the size of pipes shown to provide a
7 watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic
8 head of 40 feet of water.
- 9 4. Manufacturer: Thunderline Link-Seal, or equal.

10 **2.08 DIELECTRIC PIPE FITTINGS, UNIONS, AND BOLT INSULATORS**

11 A. General: Provide dielectric fittings, unions, and bolt insulators at all metallic piping
12 connections where dis-similar metals come into contact to prevent galvanic corrosion. As
13 these insulators are not shown on the Drawings, Contractor shall be solely responsible for
14 determining their locations:

- 15 1. Bolt insulators: Where bolt material differs from support/pipe.
- 16 2. Unions: Where two dissimilar pipe materials are joined.
- 17 3. Manufacturers: Dielectric unions shall be EPCO, Capitol Manufacturing, or equal.

18 **PART 3 – EXECUTION**

19 **3.01 GENERAL**

- 20 A. Follow piping runs specified on the Drawings as closely as possible. Submit proposed
21 deviations in accordance with the Specifications.
- 22 B. Make connections to existing structures and manholes so that the finished work will
23 conform as nearly as practicable to the requirements specified for the new manholes,
24 including necessary concrete work, cutting and shaping. Also specify concrete mortar
25 shaping within any structure and manhole.
- 26 C. Installation shall comply with the latest installation instructions published by the
27 manufacturer and shall conform to all applicable plumbing, fire, and building code
28 requirements. If there is a discrepancy between installation methods described below and
29 the manufacturer's written instruction, follow the manufacturer's written instructions.
- 30 D. Anchorage: Provide anchorage as specified. Submit calculations and Drawings for
31 proposed alternative anchorage in accordance with the Specifications.
- 32 E. All piping specialties and appurtenances shall be installed in the location shown on the
33 Drawings, unless approved otherwise, true to alignment and rigidly supported. All piping
34 specialties shall be installed in strict accordance with the manufacturers'

1 recommendations. Any piping specialty that is damaged during installation, startup and
2 testing shall be repaired at no cost to the Owner.

3 F. Install concrete inserts for pipe supports as soon as forms are erected and before concrete
4 is poured. Before setting these items, the Contractor shall check all Plans and figures
5 which have a direct bearing on their location and he shall be responsible for the proper
6 location of these piping appurtenances during the construction of the structures.

7 G. Restrained plugs, blind flanges, and caps installed for pressure testing shall be fully
8 secured and blocked to withstand the test pressure.

9 **3.02 INSTALLATION OF BURIED PIPE**

10 A. Excavating, Bedding and Backfilling for Utilities: Per WSDOT and Special Provisions.

11 B. Lines and Grades:

12 1. In position and to accurate lines, elevations, and grades as shown on Drawings.

13 2. Slope to drain where possible.

14 3. Slope pipe uniformly and continuously between control elevations shown on Drawings
15 when slope is not indicated.

16 C. Securing in Place: By blocking, brackets, clamps, or other approved methods to secure
17 pipe in place to withstand test pressure without movement.

18 D. Joint Assembly Installation:

19 1. O-Ring Joints:

20 a. Wire brush clean the exposed ends of the joint surfaces.

21 b. Thoroughly lubricate the gasket with material provided by the pipe manufacturer.

22 c. Place the gasket in the grooved spigot and relieve tension by inserting a dull
23 instrument under the gasket and completing two revolutions around the joint's
24 circumference.

25 d. Insert the joint to full metal-to-metal contact prior to providing the maximum
26 allowable 1 inch joint opening for any necessary deflection.

27 e. Electrically bond the joint through the use of welded steel bars, clips, or copper
28 wires thermite welded to the pipe in the field.

29 f. Complete the exterior and interior of the joints with appropriate coating and lining.

30 2. Field-Welded Joints:

31 a. Wire brush the exposed ends of joint surfaces.

- 1 b. A single full-fillet weld shall be provided by certified welders in accordance with
2 AWS D1.1.
- 3 c. Complete the exterior and interior of the joints with appropriate coating and lining.
- 4 E. Inspect each pipe and fitting before lowering into the trench. Inspect the interior and
5 exterior protective coatings. Patch damaged areas in the field. Clean the ends of the pipe
6 thoroughly. Remove foreign matter and dirt from inside of the pipe and keep it clean during
7 and after laying.
- 8 F. Handle pipe in a manner to avoid any damage to the pipe. Do not drop or roll pipe into
9 trenches.
- 10 G. At the location of each joint, dig bell (joint) holes in the bottom of the trench and at the
11 sides to permit completion and visual inspection of the entire joint.
- 12 H. Trenching and Backfilling: All trenching and backfilling required in connection with the
13 piping installations shall be done in accordance with the WSDOT Standard Specifications
14 and Special Provisions. No piping shall be backfilled before inspection. Pressure piping
15 shall not be backfilled until successfully tested and approved. Trenches shall be backfilled
16 without delay after approval. All trenches shall be shored and braced according to OSHA
17 requirements. Keep all trenches in a dewatered condition during pipe laying.

18 **3.03 INSTALLATION OF EXPOSED PIPE**

- 19 A. Complete installation to present neat orderly appearance, following piping runs as shown
20 on the Drawings. Submit proposed deviations in accordance with the Specifications.
- 21 B. Do not block openings or passageways with piping.
- 22 C. Run piping parallel to walls of building.
- 23 D. Keep piping free from contact with structure or installed items.
- 24 E. Allow clearances for expansion and contraction of pipe.
- 25 F. Anchor horizontal runs over 50 feet at midpoint to force expansion equally toward ends.
- 26 G. Placement of Vertical Piping:
- 27 1. Secure at sufficiently close intervals to keep pipe in alignment and to support weight
28 of pipe and contents.
- 29 2. Install supports at each floor or vertically at intervals of not more than 10 feet.
- 30 3. If piping is to temporarily stand free of support, or if no structural element is available
31 for support during construction, secure in position with wooden stakes or braces
32 fastened to pipe.
- 33 H. Placement of Horizontal Piping:
- 34 1. Support at sufficiently close intervals to maintain alignment and prevent sagging.

- 1 2. Install hangers at ends of runs or branches and at each change of direction or
2 alignment.
- 3 3. Support spacing shall not exceed the manufacturer's recommendations, nor 5 feet for
4 pipe 4 inches in diameter and smaller or 10 feet for pipe larger than 4 inches in
5 diameter, or as shown on the Drawings.
- 6 I. Support at Equipment: Install to not induce strain on equipment during or subsequent to
7 the installation of pipe work.
- 8 J. Provide flexible connection or union at all connections to equipment to facilitate removal
9 for maintenance.

10 **3.04 INSTALLATION AT CONCRETE WALLS AND FOOTINGS**

- 11 A. Install wall sleeves and wall spools in advance of pouring concrete.
- 12 B. Flexible Connections: At each exterior wall penetration and at excavation line.

13 **3.05 INSTALLATION OF BELL AND SPIGOT, PUSH-ON, AND MECHANICAL JOINT PIPE**

- 14 A. Push-On Joint Installation:
 - 15 1. Clean hub and insert gasket.
 - 16 2. Apply gasket lubricant to spigot and inside of gasket.
 - 17 3. Drive spigot into gasketed hub with pulling tool or suitable device.
- 18 B. Mechanical Joint Installation:
 - 19 1. Place gland on spigot end.
 - 20 2. Slip on rubber gasket.
 - 21 3. Slip on gasket and joint surfaces on the pipe.
 - 22 4. Thoroughly wet gasket end joint surfaces with soapy solution as recommended by
23 manufacturer.
 - 24 5. Insert spigot end to full depth with gasket pressed firmly into place in the bell in order
25 to obtain an even "set" all around the joint.
 - 26 6. Move gland into place, insert bolts, and tighten with fingers.
 - 27 7. Tighten nuts with wrench, a half turn at a time, moving from one nut to another
28 repeating until all nuts are uniformly tight.
 - 29 8. Final tightness with torque wrench to manufacturer's requirements.

1 **3.06 FLANGED PIPE INSTALLATION**

- 2 A. Tighten flange bolts so that gasket is uniformly compressed and sealed. Bolts shall be
3 tightened in a progressively crisscrossed pattern.
- 4 B. Adjoining flange faces shall be level and square. Do not distort flanges.
- 5 C. Unless otherwise noted, flanged fittings shall be installed such that the top two holes in
6 the flange are level (“two hole”).
- 7 D. Leave flange bolts with ends projecting 1/8 to 3/8 inch beyond the face of nut after
8 tightening.

9 **3.07 THREADED JOINT INSTALLATION**

- 10 A. Pipe cutting, threading, and jointing shall conform to the requirements of ANSI B31.1.
- 11 B. Threads: ANSI B2.1, NPT.
- 12 C. Cut threads full and clean with sharp dies.
- 13 D. Ream ends of pipe after threading and before assembly to remove burrs.
- 14 E. Leave not more than three pipe threads exposed at each connection.
- 15 F. Joint Sealer: Teflon thread tape.

16 **3.08 SOLVENT WELDED JOINTS**

- 17 A. Cutting:
- 18 1. Cut pipe with a knife or handsaw.
- 19 2. Make cuts square with pipe.
- 20 3. Remove burrs by smoothing edges with a knife, file, or sandpaper.
- 21 B. Joining:
- 22 1. Clean joint surfaces and apply manufacturer-recommended primer.
- 23 2. Coat with solvent cement and join.
- 24 3. Hold joint together until cement takes hold.
- 25 4. Use sufficient cement so that a bead of cement is formed between pipe and fitting at
26 socket entrance.

27 **3.09 SOLDER AND BRAZED JOINTS**

- 28 A. Ream or file pipe to remove burrs.

- 1 B. Clean and polish contact surfaces of joint.
- 2 C. Apply flux to both male and female ends.
- 3 D. Insert end of tube into fittings full depth of socket.
- 4 E. Bring joint to soldering temperature, in as short a time as possible.
- 5 F. Form continuous solder bead around entire circumference of joint.

6 **3.10 WELDED JOINT INSTALLATION**

- 7 A. Shop fabricated to maximum extent possible.
- 8 B. Use welders certified in accordance with the latest requirements of the American Welding
9 Society "Standard Qualifications Procedures."
- 10 C. Repair coating and linings to a condition equivalent to the factory applied coating or lining.
- 11 D. Install coupling at ends of pipe to be welded to provide access for replacing protective lining.
- 12 E. Welded joints shall meet the following requirements:
 - 13 1. Field-welded joints shall be butt-welded joints, butt-strap joints, or lap-welded slip-on
14 joints welded in accordance with AWWA C206 as revised herein. Butt-strap joints may
15 be flared to facilitate field fitting. However, flaring of the butt strap shall not be
16 performed in the field. Permissible variations in joint design are as follows:
 - 17 a. Miter-cut butt-strap joints and bells (for lap-welded slip-on joints) formed on bevel
18 cut ends.
 - 19 2. Lap-Welded Slip-On Joints: Where lap-welded slip-on joints are provided for welded
20 joints, the bells shall be formed by expanding with segmental dies on a hydraulic
21 expander, pressing on a plug die, or by rolling. The minimum radius of curvature of
22 any formed surface shall be 15 times the nominal thickness of the steel shell. The bell
23 ends shall be formed in a manner that does not impair the physical properties of the
24 steel shell.
 - 25 3. Linings and Coatings: Shop-applied interior linings and exterior coatings shall be held
26 back a minimum of 2-1/2 inches from the point at which the weld is to be made. Joints
27 shall be grouted or mortared in the field using sailcloth diapers, or equal, and in
28 accordance with the manufacturer's recommendations. The inside of the finished
29 (welded and grouted) joint shall have a smooth flow surface across the joint.
 - 30 4. Relative Bell Dimensions: Bell and spigot ends shall be sized to provide a difference
31 in circumferential measurement between the outside circumference of the spigot and
32 the inside circumference of the bell (or butt-strap) of not more than 0.4 inch. The
33 clearance between the spigot and bell (or butt-strap) shall be equalized around the
34 pipe circumference.
 - 35 F. Field Welding:

- 1 1. Use couplings and prefabrication of pipe systems at the factory to minimize field
2 welding to the greatest extent possible. Pipe butt welds may be performed at the job
3 site, providing the butt welds are performed only with an inert gas shielded process
4 and that other applicable specified welding requirements are rigidly adhered to.
- 5 2. Remove all residue, oxide, and heat stain from any type of field weld and the affected
6 areas adjacent by the use of stainless steel wire brushes, followed by cleaning with an
7 agent, followed by complete removal of the agent.
- 8 G. Preparation of Surfaces to Be Welded:
 - 9 1. Make surfaces of joints to be welded free from mill scale, slag, grease, oil, paint, rust,
10 and other foreign material.
 - 11 2. Wire brush joints to be welded with stainless steel wire brushes and precisely fit before
12 welding.
- 13 H. Weather Conditions:
 - 14 1. Perform welding only when the surfaces are completely free of any moisture.
 - 15 2. Do not weld the pipe during periods of high winds or rain unless the areas being welded
16 are properly shielded.
- 17 I. Tack Welds, Clips, and Other Attachments:
 - 18 1. Repair nicks, gouges, notches, and depressions in the base metal in the area of the
19 before the joint weld is made.
 - 20 2. Remove tack welds, clips, and other attachments and repair defects, except where the
21 tack welds occur within the weld area and these tack welds do not exceed the size of
22 the completed weld. Cracked tack welds shall be removed.
 - 23 3. Grind those areas to be repaired down to clean metal and then repair by building up with
24 weld metal. Grind the repaired areas smooth to form a plane surface with the base metal.
- 25 J. Defects and Repairs:
 - 26 1. Remove welds with cracks, slag inclusions, porosity, undercutting, incomplete penetration,
27 or which are otherwise deficient in quality or made contrary to any provisions of these
28 Specifications, by chipping or grinding throughout their depth to clean base metal.
 - 29 2. Do not perform calking or peening of welds to correct defects.
 - 30 3. Enlarge welds found deficient in dimension but not in quality by additional welding after
31 thoroughly cleaning the surface of previously deposited metal and the adjoining plate.
 - 32 4. Remove weld deposits, slag, weld spatter, and projections into the interior of the pipe
33 by grinding.
- 34 K. Fabrication and Installation Requirements:

- 1 1. The piping supplier during manufacturing, fabricating and handling stages, and the
2 Contractor during handling and installation stages, shall use extreme care to avoid the
3 contact of any ferrous materials with the stainless steel piping. Contact with ferrous
4 items may cause rusting of iron particles embedded in the piping walls:
 - 5 a. Stainless steel saws, drills, files, wire brushes, etc. shall be used for stainless steel
6 piping only.
 - 7 b. Pipe storage and fabrication racks shall be nonferrous or stainless steel or rubber
8 lined.
 - 9 c. Use nylon slings or straps for handling stainless steel piping.
 - 10 d. After installation, the Contractor shall wash and rinse all foreign matter from the
11 piping surface.
 - 12 e. Treat all welded joints with a pickling solution, brush with stainless steel wire
13 brushes and rinse clean.
 - 14 f. If rusting of embedded iron occurs, the Contractor shall pickle the affected surface,
15 scrub with stainless steel brushes, and rinse clean.

16 3.11 VALVES

- 17 A. General: Valves and accessories shall be installed in a manner and location as shown on
18 the Drawings or as required for the application and in accordance with manufacturer's
19 instructions. Size of valve is equal to line piping in which valve is installed unless otherwise
20 noted on the Drawings. Support all valves where necessary. In case of conflict between
21 these Specifications and a governing code, the higher standard shall prevail.
- 22 B. Joints: Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of
23 the pipe run to which the valves are attached. Clean flanges by wire brushing before
24 installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads
25 with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under
26 pressure testing, loosen or remove the nuts and bolts, reseal or replace the gasket,
27 reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.
 - 28 1. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or
29 Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.
- 30 C. Exposed Valves: Unless otherwise indicated in the Drawings, install valves in horizontal
31 runs of pipe having centerline elevations 4 feet 6 inches or less above the floor with their
32 operating stems vertical. Install valves in horizontal runs of pipe having centerline
33 elevations between 4 feet 6 inches and 6 feet 9 inches above the floor with their operating
34 stems horizontal.
 - 35 1. Install valves on vertical runs of pipe that are next to walls with their stems horizontal,
36 away from the wall. Valves on vertical runs of pipe that are not located next to walls
37 shall be installed with their stems horizontal, oriented to facilitate valve operation.

1 D. Buried Valves: Connect the valve, and place and compact the backfill to the height of the
2 valve stem.

3 1. Place block pads under the extension pipe to maintain the valve box vertical during
4 backfilling and repaving and to prevent the extension pipe from contacting the valve
5 bonnet. Mount the upper slip pipe of the extension in mid position and secure with
6 backfill around the extension pipe.

7 E. Accessories:

8 1. Provide all accessories necessary for proper valve operation as specified or required
9 for the application.

10 2. Provide extension stems for buried valve service where indicated on the Plans or
11 required for convenient operation. Provide sufficient number of adjustable cast iron
12 stem guides such that the ratio of unsupported length of stem to radius of stem does
13 not exceed 200. Small lever or handwheel operated valves may utilize handrails or
14 other suitable structure for support of extension stems.

15 F. Valve Operators: Valves shall be installed with the operator in a position for convenient
16 operation. Particular care shall be taken to ensure that space is available for operation of
17 lever or handwheel-operated valves without interference from walls, piping, or equipment.
18 Any valve that is installed, in the opinion of the Owner, in a manner that operation is
19 inconvenient, shall be modified or removed and reinstalled in a manner suitable to the
20 Owner. Operators for manual valves shall be lever or handwheel as is standard with the
21 manufacturer unless another type of operator is specified or required by the manufacturer.

22 G. Adjustments: Check and adjust valves and accessories for smooth and optimum
23 operation. Lubricate in accordance with manufacturer's recommendations. All globe,
24 angle, and gate valves shall have their stuffing boxes packed with an excess of 30% of
25 packing (for future adjustment).

26 **3.12 WALL PENETRATIONS**

27 A. For wet to dry and ground to wet or dry concrete wall penetrations, provide ductile iron
28 wall pipes with seep rings or modular seals with stainless steel type 316 bolts, nuts and
29 washers, with ductile iron wall sleeves or core drilled holes.

30 B. Modular seals shall be used on all wall or floor penetrations unless thickness of modular
31 seal exceeds wall thickness. Center pipe in penetration and use non-shrink grout where
32 modular seal cannot be installed. Modular seal is allowable in all locations as an alternative
33 to ductile iron wall pipes with seep rings. Modular seal shall be used in core drilled or cast
34 in-place modular seal type ductile iron wall sleeves, in strict accordance with
35 manufacturer's recommendations. Grout wet and ground side of penetration with non-
36 shrink grout, unless otherwise shown on the Drawings or directed by Engineer.

37 C. Ductile iron wall pipes with seep rings of the proper diameter and with suitable ends for
38 connection to adjacent pipes may be used where modular seals are not specifically called
39 for on the Drawings. Seep rings shall be installed and shall be a minimum of 2 inches
40 wide, extending at right angles and continuously welded or brazed to the pipe or cast
41 integral with the pipe. Wall pipes shall be of a class equal to or greater than the remainder

1 of the pipe in the line. Seep rings shall be installed by the pipe manufacturer at the time of
2 fabrication, unless approved by Engineer for specific application. Wall pipes shall be lined
3 per cast ductile pipe specifications. All wall sleeves in direct contact with concrete shall be
4 ductile iron.

5 **3.13 MODULAR SEALS**

6 A. Links shall be loosely assembled with bolts to form a continuous rubber belt around the
7 pipe with a pressure plate under each bolt head and nut. After the seal assembly is
8 positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to
9 expand and provide an absolutely watertight seal between the pipe and wall opening.

10 **3.14 CLEANING**

11 A. General: Equipment, pipes, valves, fittings, fixtures, appliances, etc. shall be thoroughly
12 cleaned of grease, dirt, metal cuttings, etc. and left in a satisfactory condition for use prior
13 to testing or placing system in service.

14 B. Piping: Drain and flush to remove grease and foreign matter. Thoroughly clean out valves,
15 traps, and strainers.

16 **3.15 LEAKAGE TESTING**

17 A. Preparation:

18 1. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of
19 Engineer.

20 2. Pressure Piping:

21 a. Install temporary thrust blocking or other restraint as necessary to protect adjacent
22 piping or equipment and make taps in piping prior to testing.

23 b. Prior to test, remove or suitably isolate appurtenant instruments or devices that
24 could be damaged by pressure testing.

25 c. Isolate new piping connected to existing piping with grooved-end pipe caps,
26 spectacle blinds, blind flanges, or as acceptable to Engineer.

27 d. Test Pressure: As indicated on Pipe Schedule.

28 3. Gravity Piping:

29 a. Perform testing after service connections, manholes, and backfilling have been
30 completed between stations to be tested.

31 b. Determine groundwater level at time of testing by exploratory holes or other
32 method acceptable to Engineer.

33 4. Test section may be filled with water and allowed to stand under low pressure prior to
34 testing.

- 1 5. Hydrostatic Testing for Pressure Piping:
- 2 a. Fluid: Clean water to prevent corrosion of materials in piping system.
- 3 b. Exposed Piping:
- 4 1) Perform testing on installed piping prior to application of insulation.
- 5 2) Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
- 6 3) Vent Piping During Filling. Open vents at high points of piping system or loosen
- 7 flanges, using at least four bolts, or use equipment vents to pump air pockets.
- 8 4) Maintain hydrostatic test pressure continuously for 30 minutes minimum, and
- 9 for such additional time as necessary to conduct examinations for leakage.
- 10 5) Examine joints and connections for leakage.
- 11 6) Correct visible leakage and retest.
- 12 c. Buried Piping:
- 13 1) Test after backfilling has been completed unless otherwise approved by
- 14 Engineer.
- 15 2) Expel air from piping system during filling.
- 16 3) Apply and maintain specified test pressure with hydraulic force pump. Valve off
- 17 piping system when test pressure is reached.
- 18 4) Maintain hydrostatic test pressure continuously for 2 hours minimum,
- 19 reopening isolation valve only as necessary to restore test pressure.
- 20 5) Determine actual leakage by measuring quantity of water necessary to
- 21 maintain specified test pressure for duration of test.
- 22 d. Maximum Allowable Leakage:
- 23 $L = \frac{SD(P)^{1/2}}{133,200}$
- 24 Where:
- 25 L = Allowable leakage, in gallons per hours.
- 26 S = Length of pipe tested, in feet.
- 27 D = Nominal diameter of pipe, in inches.
- 28 P = Test pressure during leakage test, in pounds per square inch.
- 29 P = Test pressure during leakage test, in pounds per square inch.
- 30 e. Correct leakage greater than allowable, and retest.
- 31 6. Pneumatic Test for Pressure Piping:
- 32 a. Do not perform on:

- 1 1) Plastic pipe.
- 2 2) Piping larger than 6 inches.
- 3 3) Buried and other non-exposed piping, unless otherwise indicated.
- 4 4) Specified test pressures above 25 psi.
- 5 5) Where hydrostatic test is possible.
- 6 b. Fluid: Oil-free, dry air.
- 7 c. Procedure:
 - 8 1) Apply preliminary pneumatic test pressure of 25 psi maximum to piping system
 - 9 prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to
 - 10 joints and connections, examine for leakage.
 - 11 2) Correct visible leaks and repeat preliminary test until visible leaks are
 - 12 corrected.
 - 13 3) Maintain pneumatic test pressure continuously for minimum of 10 minutes and
 - 14 for such additional time as necessary to conduct soap bubble examination for
 - 15 leakage.
 - 16 4) Correct visible leakage and retest.
- 17 7. Hydrostatic Test for Gravity Piping:
 - 18 a. Testing Equipment Accuracy: Plus or minus 1/2 gallon of water leakage under
 - 19 specified conditions.
 - 20 b. Maximum Allowable Leakage: 0.16 gallons per hour per inch diameter per
 - 21 100 feet. Include service connection footage in test section, subjected to minimum
 - 22 head specified.
 - 23 c. Hydrostatic Head:
 - 24 1) At least 6 feet above maximum estimated groundwater level in section being
 - 25 tested.
 - 26 2) No less than 6 feet above inside top of highest section of pipe in test section,
 - 27 including service connections.
 - 28 d. Defective Piping Sections: Replace or test and seal individual joints and retest.
- 29 B. Field Quality Control:
 - 30 1. Test Report documentation follows:
 - 31 a. Test date.

1 **1.05 SUBMITTALS**

2 A. Provide submittal data per Section 01 33 00, "Submittal Procedures".

3 B. Shop Drawings:

4 1. Layout drawings of piping supports shown on the Drawings. Drawings shall identify
5 supports, braces, hangers, guides, anchor types, materials, and finish by catalog
6 number and locations.

7 2. Supporting calculations of piping supports and seismic bracing systems.

8 C. Product data of all pipe supports, hangers, and anchoring systems.

9 **1.06 DESIGN REQUIREMENTS**

10 A. General:

11 1. Seismic Load: Seismic design shall be based on factors given in the Structural General
12 Notes found on the Drawings and in accordance with Section 13 05 41.

13 2. Design, furnish, and install all piping supports, hangers, and seismic bracing systems
14 inside the building and reservoir, regardless of whether these supports and systems
15 are shown on the Drawings. Provide seismic bracing to prevent permanent
16 displacement in any direction caused by lateral motion, overturning or uplift.

17 3. Supports are shown only where specific types and locations are required; additional
18 pipe supports may be required at these locations.

19 4. Meet requirements of MSS SP58, MSS SP69, and MSS SP89.

20 5. Contractor may use the latest edition of SMACNA/PPIC, "Guidelines for Seismic
21 Restraints of Mechanical Systems and Plumbing Piping Systems" in lieu of engineering
22 each application. Contractor shall use Hazard Level "A" as defined in the guidelines.

23 B. Pipe Support Systems:

24 1. Support Load: Dead loads imposed by weight of pipes filled with water, except air and
25 gas pipes, plus insulation.

26 2. Safety Factor: Minimum of 5.

27 3. Maximum Support Spacing and Minimum Rod Size: Shall be in accordance with the
28 Contractor's design calculations.

29 C. Framing Support System:

30 1. Beams: Size such that beam stress does not exceed 25,000 psi and maximum
31 deflection does not exceed 1/240 of span.

32 2. Column Members: Size in accordance with manufacturer's recommended method.

- 1 3. Support Loads: Calculate using weight of pipes filled with water.
- 2 4. Maximum Spans: As noted in the Standard Details or the Contractor's layout drawings.
- 3 In case of conflict between these two, the most conservative span shall apply.
- 4 D. Anchoring Devices: Design, size, and space support anchoring devices, including anchor
- 5 bolts, inserts, and other devices used to anchor support, to withstand shear and pull-out
- 6 loads imposed by loading and spacing on each particular support.
- 7 E. Vertical Sway Bracing: 10-foot-maximum centers or as shown on the Drawings.

8 **1.07 HANGER AND SUPPORT SELECTION**

- 9 A. Hanger and supports selection shall be based on the following:
- 10 1. Pipe support selections shall be based on the pipe support classifications specified in
- 11 MSS SP 69.
- 12 2. Contractor shall review the piping layout in relation to the surrounding structure and
- 13 adjacent piping and equipment before selecting the type of supports to be used at
- 14 each hanger or support location.
- 15 3. Where a particular type of pipe support is generally shown on the Drawings, that
- 16 particular design shall be used.
- 17 4. Where a particular pipe support arrangement is shown the Drawings, that particular
- 18 arrangement shall be used at that location(s).
- 19 5. Pipe support design shall conform to ASME B31.3.
- 20 6. Pipe hanger and support systems shall be coordinated with the seismic requirements
- 21 shown on the Drawings.
- 22 7. Hangers and supports shall withstand all static and dynamic conditions of loading to
- 23 which the piping and associated equipment may be subjected to. As a minimum, the
- 24 Contractor shall consider the following when designing and furnishing the pipe support
- 25 and hanger systems:
- 26 a. Weights of pipe, valves, fittings, insulating materials, suspended hanger
- 27 components, and normal fluid contents.
- 28 b. Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents
- 29 are lighter.
- 30 c. Reaction forces due to test and operational conditions.
- 31 d. Reaction forces due to operation of safety, relief, or other valves.
- 32 e. Wind, snow, or ice loading on all outdoor piping.

- 1 8. Supports shall be designed to prevent transfer of the weight of piping, valves, and
2 piping appurtenances to equipment piping connections. All adjacent supports at
3 equipment connections to piping systems shall have provisions for vertical and
4 horizontal adjustment. Two flexible piping connections not less than one pipe diameter
5 apart shall be provided between piping supports and any equipment piping connection.
- 6 9. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or the
7 outside diameter of piping insulation.
- 8 10. Where negligible movement occurs at hanger locations, rod hangers shall be used for
9 suspended lines, wherever practical. For piping supported from below, bases,
10 brackets, or structural cross members shall be used.
- 11 11. Hangers for the suspension of 2-1/2 inches and larger piping and tubing shall be
12 capable of vertical adjustment under full load conditions.
- 13 12. Supporting systems shall provide for and control the free or intended movement of the
14 piping including movement in relation to that of the connected equipment.
- 15 13. Where there is horizontal movement at a suspended type hanger location, hanger
16 components shall be selected to allow for swing. The vertical angle of the hanger rod
17 shall not, at any time, exceed four degrees.
- 18 14. There shall be no contact between a pipe, hanger, or support components of dissimilar
19 metals.
- 20 15. Pump discharges shall have, as a minimum, a fixed anchor within five diameters from
21 the discharge connection.

22 **PART 2 – PRODUCTS**

23 **2.01 GENERAL**

- 24 A. When items specified or depicted in the Standard Details are not available, fabricate pipe
25 supports material to the general configuration indicated by catalogs. All pipe supports shall
26 include braces for seismic loadings.
- 27 B. Materials:
- 28 1. Wetted and Submerged Areas: Supports shall be AISI Type 316 stainless steel.
- 29 2. Valve Vault: Supports shall be AISI Type 304 stainless steel.
- 30 3. Non-Corrosive Areas: Supports shall be hot-dipped galvanized steel.

31 **2.02 ANCHORING SYSTEMS**

- 32 A. Material:
- 33 1. Shall be hot-dip galvanized steel or stainless steel, in accordance with Paragraph 2.01.

1 B. Size: Sized in accordance with the Contractor's design calculations, 1/2-inch-minimum
2 diameter as shown on the Drawings and specified in the Special Provisions.

3 **2.03 CHANNEL TYPE SUPPORT SYSTEMS**

4 A. Metallic Channel Strut and Support Materials:

5 1. Shall be hot-dip galvanized steel or stainless steel, in accordance with Paragraph 2.01.

6 2. Channel Size: 12-gauge, 1-5/8 inch by 1-5/8 inch series.

7 3. Members and Connections: Design for all loads with safety factor of 5.

8 4. Approved Manufacturers:

9 a. Unistrut, P1000.

10 b. Approved Equal.

11 B. Non-Metallic Channel Strut and Support Materials:

12 1. Shall be pultruded glass-reinforced polyester or premium grade vinylester resin
13 fiberglass for excellent corrosion resistance.

14 2. Shall have a synthetic surfacing veil applied on exterior surfaces to improve
15 weatherability and inhibit ultraviolet degradation.

16 3. Channel Size: 1-5/8 inch by 1-5/8 inch series.

17 4. Approved Manufacturers:

18 a. Unistrut, F20P-2000, unless otherwise shown on the Drawings.

19 b. Approved Equal.

20 C. Members and Connections (Metallic and Non-Metallic Struts): Design all supporting
21 fittings, members and connections for the loads specified herein.

22 D. Strut Post Bases: Provide four-hole strut bases as specified below:

23 1. Metallic Struts: Shall be fabricated from galvanized steel and stainless steel, in
24 accordance with Paragraph 2.01. Shall be Unistrut P2072A HG and P2072A SS or
25 approved equal.

26 2. Non-Metallic Struts: Provide four-hole strut bases fabricated from glass-reinforced
27 polyester resin, Unistrut F20PU-5853, or approved equal, unless otherwise shown on
28 the Drawings.

- 1 E. Strut Pipe Straps:
- 2 1. Metallic: Shall be Standard Pipe Strap Model P2558 HG and P2558 SS series as
3 manufactured by Unistrut, or approved equal, unless otherwise shown on the Drawings.
- 4 2. Non-Metallic: Provide two-hole pipe straps fabricated from glass-reinforced polyester
5 resin, Unistrut FPS series, or approved equal, unless otherwise shown on the Drawings.
- 6 3. Tube Clamps: Shall be Unicushion Model P2600 EG and P2600 SS as manufactured
7 by Unistrut, or approved equal.
- 8 F. General Strut Fittings: Contractor shall provide all additional fittings as required to fabricate
9 the channel strut pipe support systems shown on the Drawings. All fitting materials
10 provided for the metallic and non-metallic struts shall be in accordance with
11 Paragraph 2.01.
- 12 G. Strut End Caps: Provide rubber end caps at the exposed ends of all channel struts, up to
13 7 feet above finished floor.

14 **2.04 SHOP FINISHING**

- 15 A. Prepare, prime, and finish coat all metallic piping supports in accordance with
16 Section 09 90 00, "Painting." Stainless steel and non-metallic support components shall
17 not be coated.

18 **PART 3 – EXECUTION**

19 **3.01 INSTALLATION**

- 20 A. General:
- 21 1. Install support systems in accordance with MSS SP69, "Pipe Hangers and Supports
22 Selection and Application", and MSS SP89, "Pipe Hangers and Supports Fabrication
23 and Installation", unless shown otherwise.
- 24 2. Support piping connections to equipment by pipe support and not by the equipment.
25 Pipe support components shall not be attached to pressure vessels.
- 26 3. Pipe support hangers, brackets, etc. shall be of suitable capacity and shall be
27 appropriate to the individual structural member used to support the pipe.
- 28 4. The structural integrity of any new or existing members shall not be impacted by the
29 placement of connections for pipe supports or any other embeds. For example, the
30 tension reinforcement in reinforced concrete members shall not be impacted in any
31 way by the placement of fasteners for pipe supports.
- 32 5. Pipe may be supported from the nearest structural element (floor, ceiling, wall) as long
33 as these attachments shall not cause the structural member to exceed the design live
34 load criteria shown on the Drawings.

- 1 6. Pipe supports shall not be placed at a location which will cause interference with the
2 operation of valves, equipment, or other items that need to be accessed for regular
3 operation and maintenance of the facility.
- 4 7. Support large or heavy valves, fittings, and appurtenances independently of connected
5 piping.
- 6 8. Do not support any piping from any other piping segments above or adjacent.
- 7 9. Support pipe at changes in direction or in elevation, adjacent to flexible joints and
8 couplings, and where shown.
- 9 10. Do not install pipe supports and hangers in equipment access areas.
- 10 11. Brace hanging pipes against horizontal movement by both longitudinal and lateral
11 sway bracing.
- 12 12. Install lateral supports for seismic loads at all changes in direction and where pipe
13 support does not provide adequate lateral support for tributary seismic loads.
- 14 13. Install hangers and supports to allow controlled thermal and seismic movement of
15 piping systems, to permit freedom of movement between pipe anchors, and to facilitate
16 action of expansion joints, expansion loops, expansion bends, and similar units.
- 17 14. Install pipe anchors where required to withstand expansion thrust loads and to direct
18 and control thermal expansion.
- 19 15. Repair mounting surfaces to original condition after attachments are made.
- 20 16. Any pipe support connections welded to the pressure piping shall be performed so that
21 the minimum design working pressure and thickness of the pressure piping is
22 unaffected.

23 B. Intermediate and Pipe Alignment Guides:

- 24 1. Provide pipe alignment guides (or pipe supports that provide the same function) at all
25 expansion joints and loops.
- 26 2. Guide piping on each side of an expansion joint or loop at 4 and 14 pipe-diameters
27 from each joint or loop.
- 28 3. Install intermediate guides on metal-framing support systems not carrying a pipe
29 anchor or alignment guide.

30 C. Pipe Slopes: Install hangers and supports so as not to create any intermediate high or low
31 points along each piping segment run, unless otherwise indicated on the Drawings. Pipe
32 slopes shall not exceed the maximum pipe deflections allowed by ASME B31.9 (for
33 building services piping).

34 D. Load Distribution: Install hangers and supports so piping live and dead loads and stresses
35 from movement will not be transmitted to connected equipment. Adjust hangers and

1 supports as needed to distribute loads equally on attachments and to achieve indicated
2 slope of pipe.

3 E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and
4 support together on field-assembled fiberglass struts.

5 F. Accessories:

6 1. Vibration Isolation Pad: Install under base flange or pedestal-type pipe supports within
7 3 feet of any pump or filter equipment, and other locations as required to isolate
8 vibration from the piping systems.

9 2. Dielectric Barrier:

10 a. Install between all carbon steel supports (including those with hot-dipped
11 galvanized surfaces) and copper or stainless steel pipe.

12 b. Install between stainless steel supports and dissimilar metal piping.

13 3. Electrical Isolation: Install 1/4-inch by 3-inch neoprene-rubber wrap between
14 submerged metal pipe and oversized clamps.

15 **END OF SECTION**

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SECTION 22 06 00

PIPE SCHEDULE

Pipe schedule applies to process piping and plumbing. Pipe schedule is general. Specific details may require variations from table. Where the Drawings show piping that carries two or more service designations, the piping material shall conform to the requirement for the first service listed.

Piping System per Contract Drawings	Service	System Type	Size (In.) ^a	Material	Installation	Joint Type	Lining/Coating ^b	Test Pressure and Type (psig-x)	Remarks ^c
D	Drain	Drain, Waste, Vent	All	PVC	ALL	SW	Bare/Bare	UPC	
FM	Force Main	Sanitary Sewer	All	DI	EXP BUR	FLG/GR MJ	Cement/Paint Cement/Asph	150-H	Factory coat all ductile iron pipe and fittings located in wet well per Section 09 90 00
SS	Sanitary Sewer	Sanitary Sewer	All	PVC	BUR	HU	Bare/Bare	G	ASTM D3034 SDR 35
V	Vent	Drain, Waste, Vent	All	SST PVC	EXP BUR	W SW	Bare/Bare Bare/Bare	UPC	
W, WP, WN	Water	Domestic Water	≤ 3"	COP PVC	EXP BUR	SB SW/THD	Bare/Bare Bare/Bare	125-H	Provide thrust restraint at all joints.

^a Unless noted, pipe schedule applies to all sizes for a particular service. All pipe sizes within pipe ranks may not be used. Reference Drawings for sizes used.

^b Coating systems per Spec Section 09 90 00, "Painting." "Asph" for ductile iron pipe denotes asphaltic coating per the Specifications.

^c Operating temperature is ambient or normal water temperature unless otherwise shown.

<u>Size</u>	<u>Material</u>	<u>Installation</u>	<u>Joint Type</u>	<u>Test Type</u>
">" Greater Than	"BPS" Black Steel Pipe	"All" All Installations	"FLG" Flanged	"G" Gravity Test
"<" Less Than	"CISP" Cast Iron Soil Pipe	"BUR" Buried	"FW" Fusion Welded	"H" Hydrostatic Test
"≥" Greater Than or Equal To	"COP" Copper	"EMB" Embedded (in concrete)	"GR" Grooved	"IS" In Service
"≤" Less Than or Equal To	"DI" Ductile Iron	"EXP" Exposed (interior or exterior)	"HL" Hubless	"P" Pneumatic Test
"All" All Sizes	"FRP" Fiberglass Reinforced Plastic	"SUB" Submerged	"HU" Hub and Spigot	"UPC" Test per Uniform Plumbing Code
	"GSP" Galvanized Steel Pipe		"MJ" Mechanical Joint	
	"PVC" Polyvinyl Chloride		"PO" Push-On	
	"SST" Stainless Steel		"SB" Solder/Braze	
	"STL" Mill Type Steel		"SW" Socket Welded	
			"THD" Threaded	
			"W" Welded	

END OF SECTION

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1 **SECTION 22 13 13**

2 **FACILITY SANITARY SEWER PIPING**

3 **PART 1 – GENERAL**

4 **1.01 DESCRIPTION**

- 5 A. This section specifies pipe, fittings, and connections required for the installation of sanitary
6 sewer discharge and force main. The actual pipe size and fittings shall be as shown on
7 the Drawings and described in the Pipe Schedule.
- 8 B. This specification section applies to the sewer pump station facilities associated with this
9 project.

10 **1.02 SUBMITTALS**

- 11 A. Provide submittal data per Section 01 33 00, "Submittal Procedures."
- 12 B. Prior to delivering the product to the job site, the following submittals shall be provided in
13 accordance with the specifications:
- 14 1. Shop drawings and product data:
- 15 a. Provide a complete submittal package for items specified herein per
16 Section 22 05 00, "General Requirements for Piping." Submittal package shall
17 include Manufacturer's product data, catalog cuts, or shop drawings describing
18 construction, dimensions, and materials.
- 19 2. Operation and maintenance manuals.

20 **PART 2 – PRODUCTS**

21 **2.01 DUCTILE IRON PRESSURE SEWER PIPE**

- 22 A. This Paragraph specifies sanitary sewer piping to be used in conjunction with pumps or
23 other mechanical equipment for pressure applications, 3 inches and larger.
- 24 B. Pipe: Centrifugally cast ductile iron pipe conforming to AWWA C151/A21.51. Design
25 methods shall conform to ANSI/AWWA C150/A21.50. Flanged pipe shall be Special
26 Thickness Class 53, Minimum Pressure Class 350, unless otherwise indicated on the
27 Drawings.
- 28 C. Fittings: As shown on the Drawings and in the Pipe Schedule.
- 29 D. Lining:
- 30 1. Protecto 401 Ceramic Epoxy Lining or approved equal.

- 1 E. Coating:
- 2 1. Buried Pipe: Asphaltic (bituminous) per AWWA C151/A21.51.
- 3 a. Fabricated spools that are half-buried and exposed shall be asphaltic coated
- 4 through the penetration and coated in accordance with Section 09 90 00 thereafter.
- 5 2. Exposed, Embedded, and Submerged Pipe: Do not apply asphaltic coating. Bolts and
- 6 nuts shall not be coated. Valve Vault piping and valves shall be factory coated and
- 7 shall not be field coated. See Section 09 90 00, "Painting," for coating requirements.
- 8 F. Fittings:
- 9 1. All fittings shall be lined and coated to match pipe. All joints shall be rated for a
- 10 minimum working pressure of 250 psi.
- 11 2. Push-On: AWWA C110/A21.10 and C111/A21.11, gray or ductile iron, 250 psi minimum
- 12 working pressure.
- 13 3. Mechanical: AWWA C110/A21.10, C111/A21.11, and C153/A21.53, gray or ductile
- 14 iron, 250 psi minimum working pressure.
- 15 4. Proprietary Restrained: AWWA C111/A21.11 and C153/A21.53, ductile iron, 250 psi
- 16 minimum working pressure. Romac Industries; Style RFCA or approved equal.
- 17 5. Grooved End: AWWA C606 and C110/A21.10, ductile iron, 250 psi minimum working
- 18 pressure. Victaulic or approved equal.
- 19 6. Flanged: AWWA C110/A21.10, ductile iron, faced and drilled, 125-pound flat face; or
- 20 ANSI B16.1, 250-pound raised face. Gray cast iron will not be allowed.
- 21 G. Joints:
- 22 1. As shown on the Drawings and in the Pipe Schedule.
- 23 H. Bolting: Refer to Section 22 05 00, "General Requirements for Piping."
- 24 I. Gaskets:
- 25 1. All Gaskets shall have a pressure rating equal to or exceeding the system hydrostatic
- 26 test pressure.
- 27 2. Push-On, Mechanical, and Proprietary Restrained Joints: Rubber conforming to
- 28 AWWA C111/A21.11.
- 29 3. Grooved End Joints: Halogenated butyl conforming to ASTM D2000 and AWWA C606.
- 30 4. Flanged: 1/8-inch thick, red rubber (SBR), hardness 75 (Shore A), rated to 200°F,
- 31 conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.
- 32 J. Joint Lubricant: Manufacturer's Standard.

1 **PART 3 – EXECUTION**

2 **3.01 DUCTILE IRON PRESSURE SEWER PIPE**

3 A. Install all ductile iron pipe in accordance with the latest instructions published by the
4 manufacturer.

5 B. Field Cutting: Field cutting should be limited to one piece per run of pipe for closure
6 purposes only.

7 C. Field Repair: Repair the ends of all field-cut closure pieces with a field repair kit furnished
8 by the pipe manufacturer. The area to be repaired should be free of any loose materials
9 and should be cleaned with a standard solvent to remove any grease or dirt. Prepare
10 repair product and apply per the manufacturer's recommendations. The Owner's
11 representative shall inspect each repaired end prior to installation by the Contractor.

12 **3.02 FACTORY COATED DUCTILE IRON PIPE:**

13 A. Handling: All pipes shall be handled with belt slings and padded forks to avoid damage.
14 All shipping timbers and straps shall be padded when shipping pipe.

15 B. Jobsite Repair: Any areas where damage has occurred due to handling shall be repaired
16 using a touch-up kit provided by the coating manufacturer prior to installation to equal the
17 original coating.

18 **3.03 INSPECTION AND TESTING**

19 A. All piping shall be subjected to Leakage Testing in accordance with Section 22 05 00,
20 "General Requirements for Piping." All leaks shall be repaired and lines retested as
21 approved by the Engineer. Prior to testing, all piping shall be supported and thrust
22 restrained for forces in excess of the test pressure to prevent movement during tests.

23 **END OF SECTION**

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- 1 I. Packing: Buna V-flex or TFE adjustable.
- 2 J. Ends: Flanged, grooved in accordance with AWWA C606 for rigid joints, or mechanical
3 joint for buried valves, unless otherwise noted on the Drawings.
- 4 K. Handwheel Operators: Provide handwheel operators at all exposed valve locations:
- 5 1. Totally enclosed worm gear operators with handwheel.
- 6 2. Handwheels shall not be smaller than 6 inches or larger than 18 inches.
- 7 3. Operator shall be sized for the valve operating pressure in accordance with
8 AWWA C504.
- 9 L. Buried operators:
- 10 1. See Section 22 05 00, "General Requirements for Piping," for buried operators.
- 11 M. Manufacturers and Products:
- 12 1. Milliken, 600/601 Series.
- 13 2. DeZurik, PEF.
- 14 3. Or equal.
- 15 **2.02 BALL VALVES, (STAINLESS STEEL PIPING)**
- 16 A. General: Unless otherwise noted on the Drawings, all ball valves (1-1/4 inches to 3 inches
17 in diameter) installed on metallic piping systems shall conform to the following design:
- 18 1. Size: 1-inch and Smaller.
- 19 2. Rating: 600 psi W.O.G., 150 psi SWP.
- 20 3. Type: Three-piece, full port, stainless steel construction, same as line size.
- 21 4. Body and Trim: CF8M stainless steel.
- 22 5. Ball: Type 316 stainless steel.
- 23 6. Ends: Threaded.
- 24 7. Stem Seals: PTFE.
- 25 8. Seats: Replaceable, 15% glass-filled reinforced PTFE seats suitable for water and air
26 service.
- 27 9. Operator: Lever with indicator stop.

1 B. Manufacturers and Products:

2 1. Milwaukee, 30SSOF.

3 2. Or equal.

4 **2.03 SWING CHECK VALVES (4-INCH THROUGH 12-INCH)**

5 A. Type: Full operating, swing check-type, with outside lever with adjustable weights.

6 B. Rating: 200 psi CWP.

7 C. AWWA C508.

8 D. Body and Trim: Iron body, stainless steel mounted.

9 E. Ends: Flanged.

10 F. Disc Facing: Stainless steel.

11 G. Disc Seat Ring: Buna N.

12 H. Hinge Shaft: Stainless steel.

13 I. Outside Lever Position: Right-hand and left-hand side when facing the valve inlet, as
14 shown on the Drawings.

15 J. Lever Seal: Hinge pin extended through outside lubricated bronze bushing and O-ring
16 seals.

17 K. Lubrication: Grease fittings for outside lubrication of lever seals.

18 L. Wetted parts of valve shall not contain copper or aluminum.

19 M. For swing check valves with external lever arms adjacent to plug valves, coordinate swing
20 check valve lever arm mounting position to avoid conflict with plug valve actuator.

21 N. Manufacturers and Products:

22 1. CCNE, 8000.

23 2. APCO, 6000.

24 3. Or equal.

25 **2.04 DUCKBILL CHECK VALVES**

26 A. Type: Elastomer-type with flared top/bottom contoured to a duckbilled shaped exit.

27 B. Sizes: 1 inch to 24 inches.

- 1 C. Connections: Flanged or slip-on, round entry area to match pipe.
- 2 D. Rating:
- 3 1. Approximately 2 inches of line pressure to OPEN and return to CLOSED position
- 4 under zero-flow condition.
- 5 2. Rated to 10 psi minimum operating back pressure.
- 6 E. Materials:
- 7 1. Elastomer Material: Shall be EPDM.
- 8 2. Retaining Rings: Shall be AISI Type 316 stainless steel.
- 9 F. Ends:
- 10 1. Flanged: Steel backing flange type, drilled to ANSI B16.1, Class 125.
- 11 2. Slip-On: Attached with two Type 316 stainless steel adjustable bands.
- 12 G. Manufacturers and Products:
- 13 1. Red Valve, Tideflex® Check Valve Series 35 or TF-2.
- 14 2. Or equal.

15 **2.05 COMBINATION AIR VALVE FOR SEWAGE**

- 16 A. This paragraph specifies sewage air valves for the release of air from a pipeline during
- 17 initial filling, intermittent release of smaller volumes of air during continuous operation, and
- 18 admits air into the system under vacuum conditions. The valve shall be specifically
- 19 designed to operate with liquids carrying solid particles found in wastewater. The valve
- 20 shall be designed to keep the sewage separate from the sealing mechanism to help
- 21 assure optimum working conditions.
- 22 1. Connection Size: 2-inch NPT inlet, 2-inch NPT outlet.
- 23 2. Rated Pressure: 150 psi minimum.
- 24 3. Construction: Glass reinforced Nylon body. All wetted parts shall be made of
- 25 corrosion-resistant composite materials, EPDM rubber, and/or 316 stainless steel.
- 26 Float shall be made of composite material.
- 27 4. Orifice Size: 1/8-inch and 1-1/2-inch.
- 28 5. Attachments:
- 29 a. Valve shall be supplied with non-slam, discharge throttling attachment, which
- 30 allows free air intake but throttles air discharge.

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1 **SECTION 22 13 29**

2 **SUBMERSIBLE SEWAGE PUMPS**

3 **PART 1 – GENERAL**

4 **1.01 EQUIPMENT NUMBERS**

- 5 A. Submersible Sewage Pump 1: P-1.
- 6 B. Submersible Sewage Pump 2: P-2.

7 **1.02 SUMMARY**

- 8 A. This section covers electric submersible type sewage pumps and accessories. The pumps
9 shall be designed for handling raw unscreened sewage and wastewater containing solids,
10 rags, and other fibrous materials without clogging. Pumps shall be designed for
11 heavy-duty service.
- 12 B. Furnish each pump complete with base elbow, submersible motor with integral variable
13 frequency drive, power cable, and accessories.
- 14 C. The pump manufacturer shall warrant all equipment provided under this section, whether
15 or not it is manufactured by the pump manufacturer, so that there is one source for
16 warranty and product service. Technicians specifically trained and certified by the
17 manufacturer to support the product and employed by the pump supplier shall service the
18 pumps and motors.
- 19 D. Coordination: Coordinate mounting/anchor bolt locations and requirement with wet well
20 liner fabricator.

21 **1.03 SUBMITTALS**

- 22 A. Submittals shall be provided in accordance with Section 01 33 00, "Submittal Procedures."
- 23 B. Operation and Maintenance Data shall be provided accordance with Section 01 78 23,
24 "Operation and Maintenance Data."
- 25 C. Shop drawings and product data prior to manufacture:
 - 26 1. Manufacturer, model, weight, and horsepower.
 - 27 2. Catalog information, descriptive literature, specifications, and identification of
28 materials of construction.
 - 29 3. Manufacturer's published warranty documents.

- 1 4. Pump performance curves demonstrating compliance with Pumping Conditions.
2 Indicate all specified duty points and recommended limits of operation graphically on
3 pump performance curves. Include curves for total head (feet), efficiency, brake
4 horsepower, and net positive suction head required, each plotted against flow in
5 gallons per minute (gpm).
- 6 5. Impeller type, size, and identification for Pumping Conditions.
- 7 6. Motor Submittal Data:
 - 8 a. Completed Motor Data Form.
 - 9 b. Guaranteed minimum efficiency at rated load at rated voltage.
 - 10 c. Guaranteed minimum power factor at rated load at rated voltage.
 - 11 d. Expected efficiency at 1/2, 3/4, and full load at rated voltage.
 - 12 e. Expected power factor at 1/2, 3/4, and full load at rated voltage.
 - 13 f. Motor no-load current at rated voltage.
 - 14 g. Full-load current at rated voltage.
 - 15 h. Full-load current at 110% voltage.
 - 16 i. Starting current at rated voltage.
 - 17 j. Full-load speed.
 - 18 k. Certified copy of test report for identical motor tested in accordance with
19 NEMA MG 1 Part 31 and IEEE Standard 112, Test Method B.
- 20 7. Cable Assembly Data:
 - 21 a. Insulation and conductor materials of each cable assembly.
 - 22 b. Outer diameter dimensions of each cable assembly.
 - 23 c. Cable manufacturer product data for cable.
- 24 8. Complete dimensional drawings of equipment, including pumps, motors, piping
25 connections, details of construction, and weights.
- 26 9. Guide system and discharge elbow base dimensions and materials.
- 27 10. Factory finishing system.
- 28 11. Mechanical seal information.
- 29 12. Weight of each pump.

1 13. Size and template for anchor bolts for discharge elbows.

2 14. Certificate of compliance with ISO 9001 Quality System.

3 D. Prior to factory testing:

4 1. Complete installation instructions.

5 2. Procedure for factory testing.

6 E. Prior to shipment to jobsite:

7 1. Operations and Maintenance Manuals.

8 2. Field testing procedure.

9 3. Certified factory test results:

10 a. Hydrostatic and performance.

11 F. Closeout Submittals:

12 1. Manufacturer's Certificate of Proper Installation.

13 2. Certified field test results.

14 3. Spare parts.

15 **1.04 QUALITY ASSURANCE**

16 A. Unit Responsibility: In order to ensure coordination, all pumps, motors, power cable, base
17 elbows, and accessories shall be supplied by one pump manufacturer. Electrical
18 equipment is to be supplied by the selected pump manufacturer and must conform to the
19 electrical specifications.

20 B. All pumping equipment furnished under this section shall be of a design and manufacture
21 that has been used in similar applications and it shall be demonstrated as such to the
22 satisfaction of the Owner.

23 C. To ensure a consistent high standard of quality, the manufacturer of this pumping
24 equipment shall comply with the requirements of the ISO 9001 Quality System, and such
25 compliance shall be verified by an independent certification agency approved by the
26 International Organization for Standardization. Documentation shall be submitted for
27 approval showing compliance with this requirement, and the equipment will not be
28 released for shipment until approved.

1 **1.05 SPARE PARTS**

2 A. Provide one set of the manufacturer's recommended spare parts kit. The spare parts kit
3 shall, at a minimum, include the following:

- 4 1. Inner and outer mechanical seals.
- 5 2. Upper and lower bearings.
- 6 3. One set of O-rings for the entire pump.

7 **1.06 SOURCE QUALITY CONTROL**

8 A. Each pump shall be factory tested and certified test results submitted prior to shipment of
9 pumps. The Engineer shall be given notice of the factory pump testing a minimum of
10 14 days in advance of testing.

- 11 1. Impeller, motor rating, and electrical connections shall be checked for compliance to
12 the Specifications.
- 13 2. A motor and cable insulation test for moisture content or insulation defects in
14 accordance with ANSI/HI 11.6.
- 15 3. Performance and Hydrostatic Testing: Each pump shall be operationally tested to
16 demonstrate compliance with performance requirements. The pumps shall be tested
17 at full speed with the minimum water depth specified. A minimum of eight test points
18 shall be plotted on the full speed pump curve showing horsepower, efficiency, and
19 head and flow from shut-off head to the specified run out condition plus 20%. Reduced
20 speed performance criteria may be demonstrated by applying the affinity laws to the
21 full speed test curve. During the testing, each pump shall be run continuously for a
22 minimum of 30 minutes. Performance and hydrostatic testing shall conform to the most
23 recent Hydraulic Institute Standards test codes, ANSI/HI 11.6, Acceptance Grade 1U.
- 24 4. After performance and hydrostatic testing, the cable insulation shall be tested again
25 for moisture content.
- 26 5. Tabulated and graphical test results shall be certified by the manufacturer and
27 submitted for approval by the Engineer prior to shipment of the pumps.

28 **1.07 WARRANTY**

- 29 A. The submersible sewage pumps and associated equipment shall be warranted from the
30 date of commissioning against defects in materials and workmanship.
- 31 B. Manufacturer's warranty must meet or exceed the following coverage: 100% coverage for
32 18 months, with 50% coverage for 21 months, and 25% coverage for 21 months.
- 33 C. The warranty shall be comprehensive. No deductibles shall be allowed for travel time,
34 service hours, repair parts cost, etc.

1 **1.08 PROTECTION**

- 2 A. Box, crate, or otherwise completely enclose and protect all equipment during shipment,
3 handling, and storage.
- 4 B. Protect equipment from exposure to elements, and keep all items thoroughly dry at all times.
- 5 C. Store motors, electrical equipment, and other equipment with moving parts in weathertight
6 warehouses at a maintained temperature of 60°F minimum.
- 7 D. Painted Surfaces: Protect against impact, abrasion, discoloration, and other damage.
- 8 E. Protect electrical equipment, controls, and insulation against moisture or water damage.

9 **1.09 CRITICAL SPEED AND VIBRATION**

- 10 A. Each complete pump assembly shall have no critical or resonant frequencies or multiples
11 of resonant frequencies within 30% above and 30% below the range of pump speeds and
12 blade pass frequencies required to meet the Performance Requirements. Complete
13 assemblies shall be free of objectionable or destructive vibration throughout the specified
14 operating range.
- 15 B. Vibration levels shall comply with the most recent edition of the Hydraulic Institute
16 Standards.
- 17 C. Verify that equipment is mutually compatible and free of resonance over the complete
18 operating range.

19 **PART 2 – PRODUCTS**

20 **2.01 MANUFACTURERS AND PRODUCTS**

- 21 A. Submersible Sewage Pumps:
- 22 1. Flygt Model NX6020-80.
- 23 2. No equals shall be considered.

24 **2.02 PERFORMANCE REQUIREMENTS**

- 25 A. Pumps Guaranteed Performance:
- 26 1. Pumping Condition A¹ – Rated Duty Point (Firm Capacity):
- 27 a. Capacity: 150 gpm.
- 28 b. Total Head: 24 feet.
- 29 c. Maximum Pump Speed: 1,376 rpm.
- 30 d. Minimum Efficiency: 56%.

- 1 2. Pumping Condition B¹ – Approximate Capacity at 2 Pump Operation:
- 2 a. Capacity: 204 gpm (per pump).
- 3 b. Total Head: 18.8 feet.
- 4 c. Approximate Pump Speed: 1,376 rpm.
- 5 3. Motor Nameplate²: 3 horsepower.
- 6 4. Minimum Inlet Diameter: 4.33 inches.
- 7 5. Minimum Discharge Diameter: 3.00 inches.
- 8 6. Maximum Value for NPSHr³: 11 feet.
- 9 a. NOTES:
- 10 1) Pumping conditions shall be as defined in the standards of the Hydraulic
11 Institute 1U and are exclusive of losses through the pump casing.
- 12 2) Nameplate motor horsepower shall not be exceeded at any point on the pump
13 curve within the range of operation conditions specified above. Pump shall be
14 driven from an integral Variable Frequency Drive to the pump configured to
15 limit the pump speed to 1,376 rpm or as directed by the Engineer during field
16 commissioning.
- 17 3) NPSHr is net positive suction head required by the pump, as defined by the
18 Hydraulic Institute Standards. The NPSHr of the pump shall not exceed the
19 specified value at any point within the specified range of pump operation.
- 20 B. Pumps shall operate without cavitation or undue vibration under all specified pumping
21 conditions.
- 22 C. Provide pump and motor units which are listed for explosion proof Class I, Division 1,
23 Group D hazardous location in air or submersible in water and sewage.

24 **2.03 PUMP**

- 25 A. General:
- 26 1. Submersible, wastewater pump, utilizing a semi-open impeller. The overall pump
27 design shall combine high efficiency, low required NPSH, and the ability to handle raw
28 sewage with rags and other fibrous material.
- 29 2. Sealing: All matting surfaces in pump casing and in motor housing shall be machined
30 and fitted with Nitrile or Viton rubber O-rings for watertight seal.

- 1 B. Impeller:
- 2 1. The impeller shall be hard cast iron, semiopen, multivane, back swept, screw-shaped
3 design. The leading edge shall be designed to be mechanically self-cleaned
4 automatically upon each rotation. It shall be of one-piece construction, single suction,
5 radial flow design for a circular flow pattern to prevent the accumulation of solids and
6 stringy material.
- 7 2. Impeller shall be dynamically balanced and locked to the shaft, held by an impeller
8 bolt and shall be coated with alkyd resin primer static. The arrangement shall be such
9 that the impeller cannot be loosened from torque in either forward or reverse rotation.
- 10 3. Impeller shall be standard trim for pump assembly.

11 C. Volute/Suction Cover:

- 12 1. The pump volute shall be a single piece gray cast iron, ASTM A48, Class 35B,
13 nonconcentric design with smooth passages.
- 14 2. Minimum inlet and discharge size shall be as specified.
- 15 3. The volute shall have a replaceable suction cover insert ring in which are cast
16 spiral-shaped, sharp-edged groove(s). The spiral groove(s) shall provide trash release
17 pathways and sharp edge(s) across which each impeller vane leading edge shall cross
18 during rotation so to remain unobstructed. The insert ring shall be of ASTM A532
19 25% chrome cast iron and provide effective sealing between the multivane semiopen
20 impeller and the volute housing.
- 21 4. Volute shall be provided with a guide-pin for increased clogging resistance.

22 D. Pump Shaft:

- 23 1. The pump and motor shaft shall be a single piece unit. The pump shaft is an extension
24 of the motor shaft. Shafts using mechanical couplings shall not be acceptable. The
25 shaft shall be stainless steel ASTM A479 S43100-T. Shaft sleeves will not be
26 acceptable.
- 27 2. Sufficient diameter to carry the maximum loads imposed and to prevent vibration and
28 fatigue.
- 29 3. Sufficient strength and stiffness to operate without distortion or vibration throughout
30 the range of service specified.
- 31 4. Critical speeds of rotating assembly shall be in conformance with CRITICAL SPEED
32 AND VIBRATION.
- 33 5. Capable of withstanding two times the expected peak motor torque from zero to
34 maximum speed.

- 1 E. Materials of Construction:
- 2 1. Major Castings: Gray Cast Iron, ASTM 35B.
- 3 2. Pump Housing: Gray Cast Iron, ASTM 35B.
- 4 3. Impeller: Chrome Cast Iron, ASTM A532 (25%).
- 5 4. Insert Ring: Chrome Cast Iron, ASTM A532 (25%).
- 6 5. Shaft: Stainless Steel, ASTM A479 S43100-T.
- 7 6. Screws and Nuts: Stainless Steel, A4, AISI 316L, 316, 316Ti.
- 8 7. O-rings: Nitrile (NBR) or Viton (FKM) rubber.

9 **2.04 MOTOR**

- 10 A. The pump motor shall be a synchronous permanent magnet rotor with integral variable
11 frequency drive and controller within the pump housing, shell type design, housed in an
12 oil filled, watertight chamber.
- 13 B. Provide submersible, FM approved, explosion-proof, air-filled motor suitable for
14 continuous operation on 480 V, 3-phase, 60 Hz A.C.
- 15 C. Motor starting method shall be across the line starter in tandem with integral variable
16 frequency drive and controls built into the pump assembly.
- 17 D. Design motor to be nonoverloading throughout the pump capacity-head curve for constant
18 speed pumps.
- 19 E. Minimum Full Load Efficiency: 90.4%.
- 20 F. Minimum Full Load Power Factor: 0.95.
- 21 G. Maximum Allowable Starts Per Hour: 60.
- 22 H. Thrust Bearings: Designed to take the full axial load of the impeller.
- 23 I. Dissipate excess heat directly from the exposed stator housing to surrounding pump liquid
24 for adequate motor cooling at any continuous power output.
- 25 J. Stator Windings and Leads: Insulated with moisture-resistant Class H (minimum)
26 insulation for operation at temperatures up to 180°C (minimum).
- 27 K. Protection Devices:
- 28 1. Provide temperature actuated switches embedded in the stator windings (one per
29 phase), wired in series that open a protective circuit and activate an alarm if winding
30 temperature exceeds rated operating temperature. These sensors automatically reset
31 when winding temperature has cooled to a safe operating temperature.

- 1 2. A float switch shall be installed in the seal leakage chamber and will activate if leakage
2 into the chamber occurs, signaling an alarm and stopping the motor.
- 3 3. The thermal switches and float switch shall be connected to a Mini CAS control and
4 status monitoring unit. The Mini CAS unit shall be designed to be mounted in the pump
5 control panel.

6 **2.05 ELECTRICAL POWER CORD AND SENSOR CABLES**

- 7 A. Provide suitable length of power cord and sensor cable, up to 65 feet, of extra hard usage,
8 submersible, 600 V, UL listed and/or FM approved power cord and sensor cable(s). Power
9 cable shall be sized according to NEC and ICEA standards. Provide cables for each pump
10 with:
- 11 1. Leak-proof, torque free seal at cable entry to motor.
- 12 2. Sealing of the motor power cord and sensor cable(s) to prevent moisture entry into the
13 motor due to wicking or capillary action through the cable.
- 14 3. Corrosion-resistant cable supporting means.
- 15 4. Free end of cable shall be sealed from moisture entry during shipping, storage, and
16 prior to connection by a plastic sleeve securely clamped over the cable end.

17 **2.06 SHAFT SEALS**

- 18 A. Independently-mounted, tandem mechanical seals contained in a lubricant chamber that
19 allows the seals to be completely submerged in, and lubricated by, the lubricant media.
- 20 B. Mechanical seals located between the lubricant chamber and the pump impeller shall
21 utilize one stationary and one positively driven rotating, corrosion resistant
22 carbide/tungsten carbide faces, and shall isolate the seal cooling oil from the motor frame.
- 23 C. Mechanical Seal between the lubricant chamber and the motor housing shall utilize one
24 stationary and one positively driven rotating, corrosion resistant carbide/tungsten
25 carbide faces, and shall isolate the seal cooling oil from the pump.
- 26 D. Lubrication chamber:
- 27 1. Shall be designed to prevent overfilling and to provide lubricant expansion capacity.
- 28 2. The drain and inspection plug, with positive anti-leak seal shall be easily accessible
29 from the outside.
- 30 3. The seal system shall not rely upon the pumped media for lubrication. The motor shall
31 be able to operate dry without damage while pumping under load.

1 **2.07 BEARINGS**

2 A. Bearings:

- 3 1. Antifriction-type AFBMA standard sizes.
- 4 2. Minimum (L-10) life of 50,000 hours.
- 5 3. Motor bearings shall be sealed and permanently grease lubricated.
- 6 4. Thrust ratings not less than the combined static and dynamic loads imposed.

7 **2.08 MOUNTING**

8 A. Guide Rail System:

- 9 1. Stainless steel dual guide rails mounted in the wet well as shown on the Drawings.
- 10 2. Fixture shall cantilever the entire pump and motor from the volute discharge flange,
11 providing an unobstructed sump floor under the pump.
- 12 3. Support pump with a positive metal-to-metal interlocking flange that is sealed against
13 the fixture flange by the weight of the pump.
- 14 4. A stainless steel upper rail guide bracket shall be furnished to support and align the
15 rails at the top of the sump. For all rail lengths greater than 12 feet, a stainless steel
16 intermediate rail guide bracket shall be included.

17 B. Discharge Base:

- 18 1. The installation shall include a rigid discharge base-elbow to support the total weight
19 of the pumping unit.
- 20 2. The base is to be bolted directly to the floor with the 90-degree elbow having a
21 125-pound ANSI flange discharging vertically with mounts for two 316L stainless steel
22 guide rails of standard schedule pipe.
- 23 3. Fasten base to the floor in accordance with Section 03 15 19 with 316 stainless steel
24 fastener as recommended by pump manufacturer.

25 **2.09 LIFTING SYSTEM**

26 A. Provide components for using a grip eye to lift pumps:

- 27 1. Provide at minimum a full length of stainless steel lifting chain from each pump to the
28 top of the guide rails.
- 29 2. Provide one grip eye for each pump.
- 30 3. All metal components shall be AISI Type 316 stainless steel and rated for lifting the
31 weight of the pump with a safety factor of 2.0.

1 **2.10 SHOP/FACTORY FINISHING**

2 A. Pump and Motor: All metal surfaces coming into contact with the pumpage, other than
3 stainless steel, shall be protected by a factory applied coating of amine epoxy, Sherwin
4 Williams Sher-Glass FF, 8-12 mils per coat, two coats total, or approved equal on the
5 exterior of the pump.

6 B. Pump discharge elbow shall be considered immersed piping in the wet well and shall be
7 coated as required in the painting specification.

8 **PART 3 – EXECUTION**

9 **3.01 INSTALLATION**

10 A. Install the pump as shown on the Drawings. Discharge elbow shall be mounted level.
11 Follow manufacturer’s recommendations to shim base plate as necessary to provide a
12 level installation.

13 B. Install guide rails as shown on the Drawings. Provide stainless steel upper attachment
14 support as required and shown on the mechanical details. Coordinate dimensions with the
15 pump manufacturer.

16 C. Attach the lifting chain/rope to the side wall of the opening of the pump hatch above each
17 pump. Lifting system attachment shall accommodate disassembly of the chain from the
18 anchor to assist with removal of the pump. See mechanical drawings for detail.

19 **3.02 FIELD QUALITY CONTROL**

20 A. Installation Certification: A manufacturer’s authorized representative shall inspect and test
21 each pump for proper installation, lubrication, alignment, and connection. Submit written
22 certification of installation to the Engineer.

23 B. Performance Testing: A manufacturer’s authorized representative shall witness and assist
24 with the performance testing of each pump to verify smooth operation and satisfactory
25 performance. Hydraulic performance in the project wet well shall be adequate to
26 demonstrate compliance with performance requirements.

27 C. Pump Lift Test: Contractor must demonstrate successful removal of pump from wet well
28 using manufacturer’s guide rail.

29 D. Test Results: Test results certified by the pump manufacturer’s authorized representative
30 shall be submitted to the Engineer for approval prior to the Owner’s acceptance of the
31 equipment.

32 E. Coordination: All testing shall be coordinated with the Engineer, Owner, and installing
33 Contractor prior to conducting the tests. Notify Engineer and Owner one week before
34 schedule testing.

1 F. Should tests indicate an unsatisfactory operation, such as noise, leaks, poor pump
2 performance, the manufacturer's representative shall assist the Contractor in diagnosing
3 the conditions. The malfunction shall be corrected at no cost to the Owner and the tests
4 repeated as defined herein.

5 **3.03 MANUFACTURER'S SERVICES**

6 A. Pump manufacturer shall provide a minimum of 10 hours of on-site service for certification
7 of installation, start-up testing, and training. Training shall instruct operating personnel in
8 the operation, maintenance, and adjustment of the system and installation.

9 **END OF SECTION**

1 **SECTION 26 05 11**

2 **BASIC ELECTRICAL METHODS AND MATERIALS**

3 **PART 1 – GENERAL**

4 **1.01 SECTION INCLUDES**

- 5 A. Provide electrical materials and labor to satisfactorily complete electrical work shown on
6 the Drawings, specified, or neither shown nor specified but necessary for a complete and
7 fully operating facility.
- 8 B. Mounting details of equipment, devices, light fixtures, raceways, junction boxes, etc., are
9 not usually shown or specified, provide per industry standard practice and code
10 requirements as necessary for proper installation and operation, shall be included in the
11 Contractor's estimate, the same as if specified or shown.

12 **1.02 SUBMITTALS**

- 13 A. Submittal package shall be organized by equipment type. Include separators and tabs or
14 other means of identifying each item.
- 15 B. Shop Drawings: Show dimensions, physical configurations, methods of connecting
16 equipment, mounting details, and wiring schematics. Drawings shall be complete with
17 device numbers, wire numbers, and terminal board numbers. Submit fabrication details
18 and nameplate legends. Include material lists and/or bills of material. Submit
19 manufacturer's catalog cuts for each item for which shop drawings are not required.
20 Manufacturer's catalog cuts, specifications, or data sheets shall be clearly marked to
21 delineate the options or styles to be furnished.
- 22 1. Contractor shall submit shop drawings showing conduit installation and routing to
23 Owner for review and approval prior to installing the conduit. Shop drawings shall show
24 as a minimum but not limited to the following: conduit bodies, conduit type, pull boxes,
25 wall penetrations, entry locations to electrical equipment.
- 26 2. Contractor shall submit shop drawings for each concrete equipment pad as shown on
27 the Drawings. The shop drawings for the concrete equipment pads shall also include
28 dimensions and means to anchor to concrete foundation.
- 29 C. Bill of Material (BOM): BOM shall include equipment item number, quantity, manufacturer,
30 part number, model number, and descriptions.
- 31 D. Nameplate schedule.
- 32 E. Conduit tag schedule.
- 33 F. Qualifications of testing organization and personnel meeting requirements of NETA
34 ATS-2021, Section 3.

- 1 G. Inspection and acceptance testing reports for new electrical equipment per NETA
2 ATS-2021, Paragraph 5.4 for equipment for which tests are required in this and other CSI
3 Division 26 sections.
- 4 H. Submit product information for surge protection device.
- 5 I. Submit field test results specified in Part 3 of this section.
- 6 J. Applicable operation and maintenance information on an item-by-item basis. Operation
7 and maintenance information shall be provided at the time of equipment, device, or
8 material site delivery, or at a certain stage of project completion as agreed upon with
9 Owner, whichever is the earlier. Full-size drawings shall be reduced to 11 by 17 inches.
10 Provide electronic copy of all application software with the software comments on a
11 memory stick.
- 12 K. Description of functional checkout procedures, specified in this specification, 30 days prior
13 to performing functional checkout tests.
- 14 L. Nameplate abbreviations, if required.
- 15 M. Submit operation and maintenance manuals in compliance with pertinent provisions of
16 CSI Division 1.
- 17 N. Record Drawings:
- 18 1. Contract Drawings – Upon completion of the work, transfer the Contractor maintained
19 as-built drawings to a clean set of full-size drawings with red ink to indicate additions
20 and green ink to indicate deletions. Submit these full-size drawing markups to the
21 Engineer and copy to the Owner.
- 22 2. Equipment manufacturer shop drawings – Upon completion of the work, submit the
23 as-built drawings from the equipment manufacturer with any modifications performed
24 in the field. Submit these drawings in both an Adobe Acrobat [*PDF] format and an
25 Autodesk AutoCAD [*dwg] format.

26 **1.03 QUALITY ASSURANCE**

- 27 A. Variances: In instances where two or more codes are at variance, the most restrictive
28 requirements shall apply.
- 29 B. Standards: Equipment shall conform to applicable standards of American National
30 Standards Institute (ANSI), Electronics Industries Association (EIA), Institute of Electrical
31 and Electronics Engineers (IEEE), and National Electrical Manufacturers Association
32 (NEMA). The revisions of these standards in effect on the date of issuance of the Contract
33 Documents shall apply.
- 34 C. Electrical equipment, materials, and installation methods shall conform to applicable local
35 and state codes as well as the editions of the following in effect on the date of issuance of
36 the Contract Documents:
- 37 1. National Electrical Code (NEC).

- 1 2. National Electrical Safety Code (NEC).
- 2 D. Electrical equipment must be listed or labeled by a Nationally Recognized Testing
3 Laboratory (NRTL). An NRTL is recognized by Occupational Safety and Health
4 Administration (OSHA) as being capable of independently assessing equipment for
5 compliance to safety requirements and applicable standards. UL is an example of an NRTL.
- 6 E. Provide equipment with service entrance labels in those cases where the NEC requires
7 such labels.
- 8 F. Series short circuit ratings for protective devices are not allowed.
- 9 G. For new equipment acceptance testing, studies, and reports per NETA ATS-2021 for
10 equipment for which tests are required in this and other CSI Division 26 sections.
- 11 1. Testing organization and personnel performing tests shall meet the qualifications of
12 ATS-2021, Section 3 and will be certified per ANSI/NETA ETT-2022, Standard for
13 Certification of Electrical Testing Personnel.

14 **1.04 DRAWINGS**

- 15 A. The Electrical Drawings are diagrammatic; exact locations of products shall be verified
16 with the Engineer prior to installation. Except where special details are used to illustrate
17 the method of installation of a particular piece or type of equipment or material, the
18 requirements or descriptions in this and other CSI Division 26 sections shall take
19 precedence in the event of conflict.
- 20 B. Field-verify scaled dimensions on Drawings.
- 21 C. Review the Drawings and Specification divisions of other trades and perform the electrical
22 work that will be required for the installations.
- 23 D. Submit in writing to the Engineer details of any proposed changes in or departures from
24 these Contract Documents along with the reasons, therefore. Make no changes or
25 departures without the prior written favorable review of the Engineer.

26 **1.05 JOB CONDITIONS**

- 27 A. Operations:
- 28 1. The existing pump station operations shall remain functional as specified in CSI
29 Division 1. The existing power distribution system, including the existing standby
30 power system, shall be available for use as temporary power and in support of
31 operations specified in CSI Division 1. Contractor shall provide material and labor to
32 support temporary system as specified in CSI Division 1.
- 33 2. The Contractor shall prepare and submit electrical outage plans for all electrical
34 shutdowns as specified in CSI Division 1.
- 35 a. The Contractor shall prepare and submit an electrical outage plan for the power
36 transfer of existing pump station equipment to the temporary pumping equipment
37 as specified in CSI Division 1.

- 1 b. The contractor shall prepare and submit an electrical outage plan for the power
2 transfer from the temporary equipment to the upgraded replacement pump station
3 equipment.
- 4 3. Contractor shall receive written approval prior to performing power shutdowns.
- 5 4. Contractor shall provide a minimum of 1 week advance notification with Detailed
6 Outage Plan to the Owner.
- 7 B. Maintaining Power, Instrumentation, and Controls:
- 8 1. Contractor shall field verify wiring and conduit routing at the I-5 / 4th Street and 88th
9 Street Pump Station prior to demolition to ensure equipment required during
10 construction work remain operational. Temporary wiring shall be provided to main
11 equipment operational during construction. Temporary wiring shall be removed when
12 permanent wiring is installed or when equipment is removed.
- 13 C. Construction Power:
- 14 1. Contractor is responsible to provide construction power. Contractor shall make
15 arrangements for construction power as follows:
- 16 a. Contractor can use the existing 120V receptacles for construction power.
- 17 b. Contractor shall not unplug/disconnect existing equipment from the 120V
18 receptacles.
- 19 c. Contractor shall notify the Owner of tripped circuit breakers so Owner can confirm
20 other equipment connected to branch circuit and the pump station operation has
21 been restored when circuit breaker is reset.
- 22 d. Contractor's electrical loads shall not exceed the circuit capacity of the Owner's
23 receptacles.
- 24 e. Contractor shall provide their own temporary power distribution system.
- 25 f. The Contractor shall supply any required temporary construction power electrical
26 equipment (cords, circuit breakers, power boxes, etc.).
- 27 g. If construction power is not available, then the Contractor shall provide temporary
28 construction power, portable engine generator source at no cost to the Owner.
- 29 2. When required, provide equipment, materials, and wiring in accordance with the
30 applicable codes and regulations.
- 31 3. Upon completion of the project, remove temporary construction power equipment,
32 material, and wiring from the site as the property of the Contractor.
- 33 4. Contractor provided temporary generators for construction power shall be in
34 compliance with Tulalip Tribes noise ordinance.

1 D. Storage: Provide conditioned storage for equipment and materials per manufacturer's
2 requirements that will become part of the completed facility so that it is protected from
3 weather, dust, water, and construction.

4 **1.06 DAMAGED PRODUCTS**

5 A. Notify the Owner in writing in the event that any equipment or material is damaged.

6 B. Obtain prior favorable review by the Owner before making repairs to damaged products.

7 **1.07 MATERIALS**

8 A. Provide first quality, new materials, free from defects, and suitable for the intended use
9 and space. Where two or more units of the same class of material are required, provide
10 products of a single manufacturer.

11 B. Unless otherwise indicated, provide materials and equipment that are the standard
12 products of manufacturers regularly engaged in the production of such materials and
13 equipment. Provide the manufacturer's latest standard design that conforms to these
14 Specifications.

15 **1.08 SEISMIC SUPPORT**

16 A. Mechanical, instrumentation and control, electrical, nonstructural systems, components,
17 and elements permanently attached to the structure shall be anchored and braced to resist
18 seismic forces. Contractor shall design the structural components, seismic attachment,
19 braces, and anchors to the structure for all parts or elements of the mechanical and
20 electrical systems in accordance with Section 13 05 41.

21 **1.09 WARRANTY**

22 A. The electrical equipment and installation shall begin after Substantial Completion of
23 construction.

24 1. This warranty is applicable for equipment installed, tested, and commissioned during
25 that phase.

26 2. Warranty period shall be a minimum of 1 year, unless otherwise specified.

27 3. Warranty shall include repair parts, labor, and travel expenses.

28 **1.10 LOCATIONS**

29 A. General: Use equipment, materials, and wiring methods suitable for the types of locations
30 in which they are located, as defined in Paragraph B herein.

31 B. Definitions of Types of Locations:

32 1. Dry Locations: Indoor areas which do not fall within the definitions below for Wet,
33 Damp, or Corrosive Locations and that are not otherwise designated on the Drawings.

- 1 2. Wet Locations: Locations exposed to the weather, whether under a roof or not, or
2 designated as Wet Locations by applicable codes and regulations, unless otherwise
3 designated on the Drawings.
- 4 3. Damp Locations: Location wholly or partially underground, or having a wall or ceiling
5 forming part of a channel or tank, or designated as Damp Locations by applicable
6 codes and regulations, unless otherwise designated on the Drawings.
- 7 4. Corrosive Locations:
- 8 a. The space inside the Wet Well and immediately surrounding the cover is corrosive
9 to metal. For this project, conduit and cable support hardware inside the wet well
10 shall be PVC Sch 80 or stainless steel. Fastening hardware shall be stainless steel.
- 11 5. Classified Locations: See the site plan for areas designated as classified spaces.
12 Inside classified spaces, the Contractor shall use wiring methods and electrical
13 equipment listed for use in designated classified spaces in accordance with the NEC.

14 **1.11 DELIVERY, STORAGE, AND HANDLING**

- 15 A. Contractor shall ensure electrical equipment received is stored in a dry, secured, safe
16 location, protected for water, rain, dirt, construction debris, and traffic.
- 17 B. Contractor is responsible for electrical equipment until the equipment has been
18 commissioned and successfully demonstrated to the Owner.

19 **PART 2 – PRODUCTS**

20 **2.01 STANDARD OF QUALITY**

- 21 A. It is the intent of these Specifications and Drawings to secure high quality in materials,
22 workmanship, and equipment in order to facilitate operation and maintenance of the
23 facility. Equipment and materials shall be new and the products of reputable suppliers
24 having adequate experience in the manufacture of these particular items. For uniformity,
25 only one manufacturer will be accepted for each type of product. Equipment shall be
26 designed for the service intended and shall be of rugged construction, of ample strength
27 for stresses that may occur during fabrication, transportation, erection, and continuous or
28 intermittent operation. Equipment shall be adequately stayed, braced, and anchored and
29 shall be installed in a neat and workmanlike manner. Appearance, as well as utility, shall
30 be given consideration in the design of details.
- 31 B. Components and devices installed shall be standard items of industrial grade or better,
32 unless otherwise noted, and shall be of sturdy and durable construction suitable for long,
33 trouble-free service. Light-duty, fragile, and commercial grade devices of doubtful
34 durability shall not be used.

35 **2.02 PAINTING AND COATING**

- 36 A. Equipment: Refer to each electrical equipment section of these Specifications for painting
37 and coating requirements of equipment and enclosures. Repair any final finish that has

1 been damaged or is otherwise unsatisfactory using touchup materials approved by the
2 manufacturers, to the satisfaction of the Owner.

3 **PART 3 – EXECUTION**

4 **3.01 PERMITTING**

5 A. Electrical Permit: Contractor shall submit, apply, coordinate, and pay for electrical permit.
6 Contractor shall arrange/schedule electrical inspections.

7 **3.02 GENERAL**

8 A. Work shall be performed by craftsmen skilled in their trade. Work shall present a neat,
9 finished appearance.

10 B. Install equipment in strict accordance with the manufacturer’s instructions unless directed
11 otherwise. Wherever a conflict occurs between manufacturer’s instructions, codes and
12 regulations, or these Contract Documents, follow Engineer’s direction. Keep a copy of
13 manufacturer’s installation instructions on the job site available for review at times.

14 C. Provide protection for materials and equipment against loss or damage. Protect everything
15 from the effects of weather. Prior to installation, store items in indoor locations. In addition,
16 items subject to corrosion under damp conditions, and items containing insulation, such
17 as transformers, motors, and control, shall be stored in indoor, heated, dry locations.

18 D. Following installation, protect materials and equipment from corrosion, physical damage,
19 and the effects of moisture on insulation. Cap conduit runs during construction with
20 manufactured seals. Keep openings in boxes or equipment closed during construction.

21 E. Do not cut or notch any structural member or building surface without specific approval of
22 Engineer. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls,
23 partitions, ceilings, paving, or other surfaces required for the installation, support, or
24 anchorage of conduit, raceways, or other electrical materials and equipment. Following
25 such work, restore surfaces neatly to original condition using skilled craftsmen of the
26 trades involved at no additional cost to the Owner.

27 F. Keep the premises free from accumulation of waste material or rubbish. Upon completion
28 of work, remove materials, scraps, and debris from premises and from interior and exterior
29 of devices and equipment. Touch up scratches, scrapes, or chips in interior and exterior
30 surfaces of devices and equipment with finishes matching as nearly as possible the type,
31 color, consistency, and type of surface of the original finish.

32 G. Label electrical and control equipment, including electrical pump control panels,
33 termination panels, panelboards, starter panels, generator, automatic transfer switches,
34 equipment within electrical and control panels, disconnect switches, and instrument
35 transmitters.

36 H. Concrete Equipment Pads: Contractor shall prepare shop drawings detailing the
37 construction method of the concrete equipment pad for the electrical equipment. The

1 Electrical Drawings show the locations of the electrical equipment concrete equipment
2 pads.

3 1. Shop drawings for concrete equipment pads shall be submitted after the equipment
4 submittals from the equipment manufacturers have been approved by the Owner.
5 Construction for the equipment pads shall not begin until equipment submittals and
6 shop drawings are approved.

7 **3.03 GROUNDING**

8 A. Bond and ground equipment for which a ground connection is required per NEC whether
9 not specifically shown on the Drawings.

10 **3.04 START-UP FIELD SERVICE**

11 A. Contractor shall ensure manufacturer representative of new equipment and existing
12 equipment support startup, testing, and commissioning.

13 **3.05 FIELD TESTS**

14 A. Perform inspection and acceptance testing and submit test reports for the equipment
15 specified in Section 26 08 00, "Electrical Testing and Commissioning," and as specified in
16 all CSI Division 26 sections.

17 B. Give a 2-week notice to the Engineer and Owner prior to any test to permit witnessing the
18 test.

19 C. Retesting will be required for unsatisfactory tests after the equipment or system has been
20 repaired. Retest related equipment and systems if required by the Engineer. Repair and
21 retest equipment and systems that have been satisfactorily tested but later fail, until
22 satisfactory performance is obtained.

23 **3.06 FINAL CLEANING**

24 A. Contractor shall provide final cleaning of electrical equipment and workspaces and work
25 areas.

26 B. Contractor shall clean all items worked on under this Contract. Contractor shall leave work
27 areas free of stains, damage, or other defects prior to final acceptance.

28 1. Cleaning shall include wiping, sweeping, and vacuuming to leave work areas and
29 equipment free of dust, debris, and moisture.

30 C. Pump Control Panel:

31 1. Cleaning shall include vacuuming the interior and wiping clean the top of the enclosure
32 of dust, dirt, construction debris.

1 **3.07 RECORD DRAWINGS**

2 A. Maintain a set of as-built drawings on site that documents changes made to both the
3 Contract Drawings and approved equipment manufacturer shop drawings.

4 B. At the completion of the project, Contractor shall submit a set of as-built drawings which
5 include the as-built redlines from the project. Contractor shall submit redlines to
6 manufacturer's shop drawings.

7 1. Nonlegible redlines will be rejected and return to the Contractor to improve and re-
8 submit.

9 **END OF SECTION**
10

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1 2. UL 44 for rubber or rubber-like and cross-linked thermosetting polyethylene insulated
2 wire and cable.

3 B. Provide copper wire only.

4 C. No underground splices allowed unless approved by the Owner.

5 **2.02 WIRE AND CABLE IN RACEWAY**

6 A. Lighting, and general-purpose receptacles:

7 1. Insulation: Type XHHW-2 rated 600 V.

8 a. Cross-Linked Polyethylene (XLPE) Insulation.

9 b. High-Heat and Moisture Resistant:

10 1) Used in wet and dry locations at temperatures not to exceed 90°C.

11 c. Gas, Oil, and UV Resistant.

12 2. Use stranded wire for all conductors.

13 3. Control conductor wire size: #14 AWG - #10 AWG.

14 B. Power:

15 1. Insulation: Type XHHW-2 rated for 600 V.

16 a. Cross-Linked Polyethylene (XLPE) Insulation.

17 b. High-Heat and Moisture Resistant:

18 1) Used in wet and dry locations at temperatures not to exceed 90°C.

19 c. Gas, Oil, and UV Resistant.

20 2. Use stranded wire for all power conductors.

21 3. Use minimum #12 AWG conductors for receptacles and lighting.

22 **2.03 JOINTS, TAPS, SPLICES, AND TERMINATIONS**

23 A. Conductors #10 AWG and Smaller: Use twist type insulated wire nut solderless
24 connectors. The twist type insulated wire nut solderless connectors are only allowed for
25 lighting and 120V receptacles branch circuits.

26 B. Conductors #8 AWG and Larger: Use solderless compression type connectors that will
27 not loosen under vibration or normal strains.

- 1 C. Control and Instrumentation Conductors: Use crimp-type spade connectors where control
2 wires are connected to screw terminals of equipment.
- 3 D. Joints, Taps, and Splices Located in Enclosures Subject to Moisture: Use watertight splice
4 kits.
- 5 1. Contractor shall obtain written approval for each location where wiring splices are
6 required.
- 7 E. Contractor shall obtain written approval from Owner prior to splicing feeder conductors or
8 instrumentation/control wiring.

9 **2.04 COLOR CODING**

10 A. General:

- 11 1. Multiconductor control cable colors shall be manufacturer's standard.

12 B. Control Conductors:

- 13 1. Provide conductors with a minimum of five unique insulation colors for the installation
14 of control conductors within the same raceway. Do not use brown, orange, and yellow
15 for control conductor insulation colors. Provide equal distribution of colors.

16 C. Power Conductors:

- 17 1. Power conductors shall be color coded in accordance with the following table. For
18 multiconductor cables, colored tape may be applied to the ends to provide the required
19 color code.

Use	Cable	Color
Three-phase, 120/240 V power	Phase A	Black
	Phase B	Red
	Phase C	Blue
	Neutral	White
	Ground	Green, Green with Yellow stripe.

- 20 2. Conductors sized #4 AWG and larger may be black with colored 3/4-inch vinyl plastic
21 tape applied in 3-inch lengths around the cable at each end.
- 22 3. Mark the conductor cables at terminations and on cables in pull boxes.
- 23 4. Provide identification of the coding scheme at branch circuit distribution equipment in
24 accordance with the requirements of NEC 210.5 and 215.12.

1 **2.05 PERMANENT WIRE MARKERS**

- 2 A. Provide as specified in Section 26 05 53, "Identification for Electrical Systems."

3 **PART 3 – EXECUTION**

4 **3.01 CONTROLS CONDUCTORS**

- 5 A. Reference Section 26 05 23, "Signal Cable."

6 **3.02 INSTALLATION**

- 7 A. Install wiring and cable as specified in Conduit and Cable Schedules.
- 8 B. Install wiring system in accordance with manufacturer's recommendations.
- 9 C. Install wire and cable in conduit unless otherwise shown on the Drawings.
- 10 D. Maintain barrier, physical separation, or conduit separation between power conductors
11 and instrumentation conductors to avoid magnetic interaction where such conductors
12 enter and pass-through same manhole, handhole, casing pipe, box, electrical trough, or
13 enclosure.
- 14 E. Exercise care in pulling wires and cables into conduit or wireways so as to avoid kinking,
15 putting undue stress on the cables, or otherwise abrading them. No grease will be permitted
16 in pulling cables. Only listed pulling compound will be permitted. The raceway construction
17 shall be complete and protected from the weather before cable is pulled into it. Swab
18 conduits before installing cables and exercise care in pulling to avoid damage to conductors.
- 19 F. Cable bending radius shall be per applicable code. Install feeder cables in one continuous
20 length.
- 21 G. Provide an equipment-grounding conductor, whether or not it is shown on the Drawings,
22 inside any flexible conduit or any raceway in which all or any portion of a run consists of
23 nonmetallic duct or conduit. External bonding jumpers are not acceptable.
- 24 H. In panels, bundle incoming wire and cables, #6 AWG and smaller; lace at intervals not
25 greater than 6 inches; neatly spread into trees and connect to respective terminals. Allow
26 sufficient slack in cables for alterations in terminal connections. Perform lacing with plastic
27 cable ties or linen lacing twine. Where plastic panel wiring duct is provided for cable runs,
28 lacing is not necessary when the cable is properly installed in the duct.
- 29 I. For cables crossing hinges, utilize extra flexible stranded wire, make up into groups not
30 exceeding 12, and arrange so that there will be protection from chafing and excess flexing
31 when the hinged member is moved.

32 **3.03 CONDUCTOR SPLICES AND TERMINATIONS**

- 33 A. Splices:

- 1 1. Install conductors without splices unless necessary for installation, as determined by
2 the Owner. Splices, when permitted, and terminations shall be in accordance with the
3 splice or termination kit manufacturer's instructions. Splice or terminate wire and cable
4 as follows:
- 5 a. Watertight Splices: Splices in concrete pull boxes, for any type of cable or wire,
6 shall be watertight. Make splices in low-voltage cables using epoxy resin splicing
7 kits rated for application up to 600 V.
- 8 B. Terminations: Terminate stranded #14 wire using crimp-type terminals where not
9 terminated in a box lug-type terminal. Terminals must be coordinated with type of terminal
10 board where provided.

11 **3.04 CONDUCTOR IDENTIFICATION**

- 12 A. Install as specified in Section 26 05 53, "Identification for Electrical Systems."

13 **3.05 FIXTURE OUTLETS**

- 14 A. Use minimum AWG #12 wire for conductors supplying power to single fixture.

15 **3.06 FIELD TESTS**

- 16 A. Perform inspection and acceptance testing and submit test reports for the equipment
17 specified in this section and other CSI Division 26 sections.
- 18 B. Give a 2-week notice to the Owner prior to any test to permit witnessing the test.
- 19 C. Retesting will be required for all unsatisfactory tests after the equipment or system has
20 been repaired. Retest all related equipment and systems if required by the Owner. Repair
21 and retest equipment and systems that have been satisfactorily tested but later fail, until
22 satisfactory performance is obtained.
- 23 D. Field Test Report:
- 24 1. A field test report shall be prepared and submitted as a single bound submittal package
25 and shall include each test specified in this section and other CSI Division 26 sections.
26 Include separators and tabs, or other means of identification, for each individual test.
- 27 2. The test data records shall include the following:
- 28 a. Identification of the testing technician and organization.
- 29 b. Equipment identification.
- 30 c. Description of test method and equipment, including test equipment calibration
31 dates.
- 32 d. Identification of conditions that may affect the test results such as humidity and
33 temperature.

- 1 e. Date and time.
- 2 f. Inspection and test results. For each test, include range of acceptable test values.
- 3 g. Indication of “as-found” and “as-left” results, as applicable.
- 4 h. Comments and test summary.
- 5 E. Conductor Insulation Test:
- 6 1. Perform an insulation resistance test for each conductor with a circuit voltage above
- 7 150 V to ground.
- 8 2. Test procedure shall conform to NETA ATS.
- 9 3. Insulation-resistance test values shall not be less than 100 megohms.
- 10 F. Phase Rotation: The phase rotation of all circuits shall be clockwise in sequence. The
- 11 Contractor shall verify that each three-phase service, feeder, and branch circuits meet this
- 12 requirement. A record shall be kept at each circuit tested and, on completion, submitted to
- 13 the Owner for review.

14 **END OF SECTION**

1 **SECTION 26 05 23**

2 **SIGNAL CABLE**

3 **PART 1 – GENERAL**

4 **1.01 SUMMARY**

- 5 A. This section specifies products and procedures for furnishing, installing, and connection
6 of conductors and cables for signal circuits.
- 7 B. Provide low-voltage wire and cable as shown on the Drawings, as specified herein, and
8 as needed for a complete and proper installation.

9 **1.02 QUALITY ASSURANCE**

- 10 A. Comply with the following requirements:
- 11 1. NFPA 70 National Electrical Code (NEC).
- 12 2. Local codes and ordinances.

13 **1.03 SUBMITTALS**

- 14 A. Shop Drawings: Submit product information/data shop drawings for materials in accordance
15 with Section 26 05 11, "Basic Electrical Methods and Materials."
- 16 B. Submit operation and maintenance manuals in compliance with pertinent provisions of
17 CSI Division 1.

18 **1.04 WARRANTY**

- 19 A. Manufacturer warrants their product will be free from defects in material or workmanship
20 for a 1-year period. The product warranty shall begin at time of equipment start-up.

21 **1.05 DELIVERY, STORAGE, AND HANDLING**

- 22 A. Contractor shall ensure electrical equipment received is stored in a dry, secured, safe
23 location, protected for water, rain, dirt, construction debris, and traffic.
- 24 B. Contractor is responsible for electrical equipment until the equipment has been
25 commissioned and successfully demonstrated to the Owner.

26 **PART 2 – PRODUCTS**

27 **2.01 GENERAL**

- 28 A. Comply with the following standards:
- 29 1. UL 83 and ICEA S-61-402 for thermoplastic insulated wire and cable.

1 2. UL 44, ICEA S-19-81 and ICEA S-66-524 for rubber or rubberlike and crosslinked
2 thermosetting polyethylene insulated wire and cable.

3 B. Provide copper wire only.

4 **2.02 WIRE AND CABLE**

5 A. Multi-conductor Tray Cable (600 V):

6 1. 600 V Rated:

7 a. Cable shall be a multi-conductor, tray rated, with minimum wire gauge #18 AWG
8 unless specified on Drawings, UL Listed.

9 b. Jacket Insulation: Jacket shall be suitable for installations in wet or dry locations,
10 resistant to sunlight, moisture, and vapor penetration. cross-linked poly-ethylene
11 compound or PVC per UL Standard 1277.

12 c. Conductor: Soft bare annealed copper per ASTM B3, Class B stranding per
13 ASTM B8.

14 d. Conductor Insulations: Flame-retardant PVC per UL Standard 83 for Type THWN
15 wire or Okoseal insulation with nylon jacket.

16 e. Standards: UL Type TC per Article 336 of the NEC, IEEE 383 (70,000 BTU/hour)
17 Flame Test, ICEA (210,000 BTU/hour) Flame Test.

18 f. Suitable for Use: Indoors and outdoors, aerially, in conduits, ducts, cable trays, or
19 direct burial in circuits not exceeding 600 V, UL approved for use in continuous
20 operation at 75°C in wet locations, 90°C in dry locations, 130°C for emergency
21 overload conditions.

22 g. Acceptable Manufacturers: Belden, Okonite, or approved equal.

23 B. Twisted Shielded Pairs Cable (TSP):

24 1. 600 V Rated:

25 a. Cable shall be single twisted, shielded pair, #16AWG, instrumentation cable, UL
26 listed.

27 b. Jacket: Jacket shall be suitable for installations in wet or dry locations, resistant to
28 sunlight, moisture, and vapor penetration, PVC per UL Standard 1277.

29 c. Conductor Insulations: PVC-nylon or XLP or Okoseal insulation with nylon jacket,
30 45-mil PVC, 600 V rated.

31 d. Conductor: Bare annealed copper, stranded in accordance with ASTM B8.

32 e. Conductor Insulation: 15-mil, 90°C, polyvinylchloride (PVC).

- 1 f. Shield and drain wire integral to cable.
- 2 g. Standards: UL 1277, IEEE383, UL listed .
- 3 h. Approved for Use: Indoors or outdoors; wet or dry locations; in cable trays; in
4 raceways; for direct burial; and in Class I, Division 2 location (NEC Article 501).
- 5 i. Acceptable Manufacturers: Belden, Okonite, or approved equal.
- 6 2. 300 V Rated:
- 7 a. Contractor shall obtain written approval from Owner prior to application of 300 V
8 rated TSP cable.
- 9 b. 300 V rated instrumentation cable is allowed where routed in dedicated raceways,
10 physically separated from 600 V rated cable by means of cable management
11 clamps, ducts, barriers, etc., which maintain a distance of 4 inches from 600 V
12 rated cable.
- 13 c. Cable shall be single twisted, shielded pair, #16 AWG, instrumentation cable, UL
14 listed.
- 15 d. Jacket: 32-mil PVC, 300 V rated.
- 16 e. Conductor: Bare annealed copper, stranded in accordance with ASTM B8.
- 17 f. Conductor Insulation: 31.5-mil, 80°C, polyethylene (PE).
- 18 g. Shield: Foil Shield with #18 AWG Drain wire, stranded.
- 19 h. Standards: UL 1277, UL listed.
- 20 i. Approved for Use: Indoors or outdoors, wet or dry locations, in cable trays, and in
21 raceways.
- 22 j. Acceptable Manufacturers: Belden, General Cable, Southwire, or approved equal.
- 23 C. Twisted Shielded Triad Cable (TST):
- 24 1. 600 V Rated (Preferred):
- 25 a. Cable shall be single twisted, shielded triads, 16 AWG, instrumentation cable, UL
26 listed.
- 27 b. Jacket: Jacket shall be suitable for installations in wet or dry locations, resistant to
28 sunlight, moisture, and vapor penetration, PVC per UL Standard 1277.
- 29 c. Conductor Insulations: PVC-nylon or XLP or Okoseal insulation with nylon jacket,
30 45-mil PVC, 600 V rated.
- 31 d. Conductor: Bare annealed copper or tinned copper, stranded in accordance with
32 ASTM B8.

- 1 e. Conductor Insulation: 15-mil, 90°C, PVC.
- 2 f. Shield and drain wire integral to cable.
- 3 g. Standards: UL 1277, IEEE383, UL listed.
- 4 h. Approved for Use: Indoors or outdoors; wet or dry locations; in cable trays; in
- 5 raceways; for direct burial; and in Class I, Division 2 location (NEC Article 501).
- 6 2. Acceptable Manufacturers: Belden, Okonite, Okonite or approved equal.
- 7 D. Ethernet Cable:
- 8 1. CAT5e:
- 9 a. Cable shall exceed Category 5E component transmission requirements specified
- 10 in ANSI/TIA/EIA-568-C.2 and shall be tested to 100 MHz.
- 11 b. UL Temp Rating: 75°C.
- 12 c. Cable shall exceed IEEE 802.3 DTE Power specification to the rated current limits
- 13 with no degradation of performance or materials.
- 14 d. Cable shall be error free Gigabit Ethernet performance to IEEE 802.3.
- 15 e. Cable shall meet or exceed the 4-conductor channel performance requirements of
- 16 Category 5e, per the ANSI/TIA/EIA-568-C.2 standard.
- 17 f. Product: Construction shall be four twisted pairs of 22 – 24 AWG insulated solid
- 18 conductors.
- 19 g. Conductor insulation: PO-Polyolefin.
- 20 h. Overall outer foil shield (100% coverage).
- 21 i. Overall Cable Insulation Voltage Rating: 300 V RMS.
- 22 j. Overall outer jacket material – Industrial Grade PVC – Polyvinyl Chloride.
- 23 k. Connector: 50-micron gold plated RJ-45.
- 24 l. UL Listed – UL 444.
- 25 m. Warranty: Lifetime.
- 26 E. Singlemode Fiber Optic Cable (SMF):
- 27 1. Number of Fibers in Cable: 4 fibers (minimum).
- 28 2. Type of Fiber (optical): Singlemode nondispersion shifted, 9/125 micrometer (core
- 29 diameter/cladding diameter).
- 30 3. Jacket:

- 1 a. Polyvinyl chloride (PVC).
- 2 b. Color: Black.
- 3 4. Constructed with a central strength member/filler and optical fibers within Aramid Yarn
- 4 strength member/WB with a ripcord and all enclosed with the PVC outer jacket.
- 5 5. Storage and Operating Properties: -40°C to +85°C.
- 6 6. Rated for both indoor and outdoor application and burial in conduit.
- 7 7. UV, water, and fungus resistant.
- 8 8. Flame resistance UL 1666.
- 9 9. Helically stranded core for flexibility and mechanical protection of the optical fibers.
- 10 10. Glass fiber core.
- 11 11. Installation minimum Bend Radius no smaller than 8 inches.
- 12 12. Fiber color code shall conform to TIA/EIA 598-C.
- 13 13. Acceptable Manufacturer:
 - 14 a. Optical Cable Corporation.
 - 15 b. Belden.
 - 16 c. General Cable.
 - 17 d. Or approved equal.
- 18 F. Fiber Optic Connector:
 - 19 1. Provide fiber optic connector compatible with fiber optic cable the Ethernet to Fiber
 - 20 Converter located in Pump Control Panel.
 - 21 2. Provide a 100% waterproof IP68 outdoor rated fiber optic connector connection in
 - 22 communication handhole shown on drawing. Connector shall be compatible with fiber
 - 23 optic cable and existing fiber optic cable for splice connection.
 - 24 a. Connector shall be chemical/oil resistant, UV resistant, and rodentproof.

25 **2.03 SPECIFIED CABLE**

- 26 A. The Contractor shall provide the cable specified in the Drawings and these specifications.

27 **2.04 COPPER WIRE JOINTS, TAPS, SPLICES, AND TERMINATIONS**

- 28 A. Conductors #10 AWG and Smaller: For terminations, Contractor shall use crimp-type
- 29 spade connectors where control wires are connected to screw terminals of equipment.

- 1 Contractor shall obtain written approval from Owner prior to splicing instrumentation and
2 control conductors.
- 3 B. Control and Instrumentation Conductors: Use crimp-type spade connectors where control
4 wires are connected to screw terminals of equipment.
- 5 C. Joints, Taps, and Splices Located in Enclosures Subject to Moisture: Use watertight splice
6 kits.

7 **2.05 FIBER OPTICS SPLICES AND TERMINATIONS**

- 8 A. Connectors:
- 9 1. Type ST, SMA, or as specified.
- 10 2. Connectors shall be tool-affixed and listed for the specific application as recommended
11 by the utilization equipment manufacturer.
- 12 3. Single-fiber cables with factory installed connectors of suitable type are acceptable.
- 13 4. Acceptable manufacturers: Amp, Amphenol, or approved equal.
- 14 B. Breakout Kits:
- 15 1. Shall consist of heat-shrinkable, polymeric insulating material over the connection area
16 and a high dielectric strength mastic to seal the ends against ingress of moisture and
17 contamination.
- 18 2. Shall accommodate a range of cable sizes for both in-line and stub-type
19 configurations.
- 20 3. Shall be independent of cable manufacturer's tolerances.
- 21 4. Acceptable manufacturers: Belden, Alpha, or approved equal.

22 **2.06 PERMANENT WIRE MARKERS**

- 23 A. Provide as specified in Section 26 05 53, "Identification for Electrical Systems."

24 **PART 3 – EXECUTION**

25 **3.01 INSTALLATION**

- 26 A. Install wiring and cable as specified in Conduit and Cable Schedules.
- 27 B. Signal cable shall be installed by personnel who have had a minimum of 3 years of
28 experience in terminating and splicing twisted shielded conductors.
- 29 C. Adequate care shall be exercised by the installers to prevent cable damage or sheath
30 distortion. Bending radius shall be per manufacturer's recommendations and not be less
31 than 10 times the cable's overall diameter.

- 1 D. Cables shall be continuous from initiation to termination without splices except where
2 specifically indicated.
- 3 E. Cable shielding shall be grounded at one end only of the cable. Bonding shall be to a
4 single ground point only. Bonding from cable-to-cable in multiple-run installations shall not
5 be permitted.
- 6 F. Heat-shrinkable sleeves shall be installed on cables to insulate shielding at the ungrounded
7 cable terminations.
- 8 G. Where installed in control consoles containing power circuits, cables shall be routed a
9 minimum of 2 inches distant. Color-coding shall be strictly observed throughout the
10 installation.
- 11 1. Maintain barrier, physical separation, or conduit separation between instrumentation
12 conductors and power conductors to avoid magnetic interaction where such conductors
13 enter and pass through the same electrical trough or enclosure.
- 14 H. Manufacturer's cable-pulling tension shall not be exceeded.
- 15 I. Fiber Optic Cable Pulling:
- 16 1. Complete the pulling of optical fiber cable into conduit or trays without damaging or
17 putting undue stress on the cable insulation.
- 18 2. Soapstone, talc, or UL listed pulling compounds are acceptable lubricants for pulling
19 optical fiber cable.
- 20 3. Grease is not acceptable.
- 21 4. Raceway construction shall be complete, cleaned, and protected from the weather
22 before cable is placed.
- 23 5. Whenever a cable leaves a raceway, provide a cable support.

24 **3.02 CONDUCTOR SPLICES AND TERMINATIONS**

- 25 A. Copper Conductor Splices:
- 26 1. Install conductors without splices, unless necessary for installation, as determined and
27 approved in writing by the Engineer. Splices, when permitted, and terminations shall
28 be in accordance with the splice or termination kit manufacturer's instructions. Splice
29 cables as follows:
- 30 a. Watertight Splices: Splices in concrete pull boxes, for any type of cable or wire,
31 shall be watertight. Make splices in low-voltage cables using epoxy-resin splicing
32 kits rated for application up to 600 V.
- 33 b. Shields shall be handled as a separate conductor. Use manufacturer's
34 compression sleeve and insulated pigtail. Keep pigtail as short as possible.
35 Terminate pigtail with marker sleeve and tug.

1 B. Copper Conductor Terminations:

- 2 1. Crimp-type terminals shall be Listed, self-insulating, sleeve type with ring or
3 rectangular tongue, suitable for size and material of the wire to be terminated and for
4 use with stranded wire. Spade type lugs are acceptable with telephone cable (TC)
5 systems only.
- 6 2. Crimp with manufacturer's recommended ratchet-type tool with calibrated dyes. Crimp
7 shall follow manufacturer's termination instructions.

8 C. Fiber Optic Cables:

9 1. Lacing and Bundling:

- 10 a. Lace and bundle individual optical fiber cables in panels and electrical equipment
11 at intervals not greater than 6 inches, spread into trees and connected to their
12 respective terminals.
- 13 b. Lacing shall be made up with plastic cable ties.
- 14 c. Lacing is not necessary in plastic panel wiring duct.
- 15 d. Bundle individual optical fiber cables crossing hinges into groups not exceeding
16 eight fibers and arrange so that they will be protected from chafing when the hinged
17 member is moved.

18 2. Slack:

- 19 a. Provide slack in junction and pull boxes, handholes, and manholes.
- 20 b. Slack shall be sufficient to allow cables to be routed along the walls of the box.
- 21 c. Amount of slack shall be equal to largest dimension of the box.
- 22 d. Where plastic panel wiring duct is provided for wire runs, lacing is not required.
- 23 e. Do not use plastic panel wiring duct in manholes and handholes.

24 3. Individual Fibers:

- 25 a. Break out individual fibers from multi-fiber cables utilizing Breakout Kits as
26 specified by cable manufacturer.
- 27 b. Terminate individual fibers with connectors as required by the utilization
28 equipment.
- 29 c. Install connectors using manufacturer's recommended tools.

30 4. Raceway fill limitations shall be as defined by NEC and the following:

- 31 a. Optical fiber cables may be run in the same raceway with electrical conductors
32 provided derating requirements of the NEC are observed.

- 1 5. Unless otherwise indicated, bond armoring of multi-fiber cables to the chassis ground
2 bus at the control panel or per NEC at other locations. Provide terminals for running
3 grounding wires through junction boxes.
- 4 6. Terminal Boxes:
 - 5 a. Provide at optical fiber cable splices.
 - 6 b. If cable is buried or in raceway below grade at splice, provide an instrument stand
7 as specified with terminal box mounted approximately 3 feet above grade.
- 8 7. Install and terminate cable in compliance with the manufacturer's recommendations.

9 **3.03 CONDUCTOR IDENTIFICATION**

- 10 A. Install as specified in Section 26 05 53, "Identification for Electrical Systems."

11 **3.04 FIELD TESTS**

- 12 A. Perform inspection and acceptance testing and submit test reports for the equipment
13 specified in this section and other CSI Division 26 sections.
 - 14 1. A field test report shall be prepared and submitted as a single bound submittal package
15 and shall include each test specified in this section and other CSI Division 26 sections.
16 Include separators and tabs, or other means of identification, for each individual test.
 - 17 2. The test data records shall include the following:
 - 18 a. Identification of the testing technician and organization.
 - 19 b. Equipment identification.
 - 20 c. Description of test method and equipment, including test equipment calibration
21 dates.
 - 22 d. Identification of conditions that may affect the test results, such as humidity and
23 temperature.
 - 24 e. Date and time.
 - 25 f. Inspection and test results. For each test, include range of acceptable test values.
 - 26 g. Indication of "as-found" and "as-left" results, as applicable.
 - 27 h. Comments and test summary.
- 28 B. Continuity Testing:
 - 29 1. Perform a continuity test on control and signal copper wiring.
 - 30 a. Verify single conductors are not accidentally shorted to ground or to each other.

1 **SECTION 26 05 26**

2 **GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

3 **PART 1 – GENERAL**

4 **1.01 SUMMARY**

- 5 A. This section specifies the system for grounding electrical equipment and for
6 building/structure ground electrode systems.

7 **1.02 REFERENCE STANDARDS**

- 8 A. Referenced Standards: This section incorporates by reference the latest revisions of the
9 following documents. In case of conflict between the requirements of this section and the
10 listed documents, the requirements of the Contract Specifications shall prevail.

- 11 1. NFPA 70: National Electric Code (NEC).
12 2. UL 467: Standard for Grounding and Bonding Equipment.

13 **1.03 SUBMITTALS**

- 14 A. Shop Drawings: Submit product information/data shop drawings for materials in
15 accordance with Section 26 05 11, "Basic Electrical Methods and Materials," and
16 Section 01 33 00, "Submittal Procedures."

- 17 B. Submit product catalog cut sheets.

- 18 C. Submit operation and maintenance manuals in compliance with pertinent provisions of
19 CSI Division 1.

- 20 D. Test data.

21 **1.04 QUALITY ASSURANCE**

- 22 A. Source Quality Control: Products shall be listed and labeled by an approved
23 Nationally Recognized Testing Lab (NRTL) such as Underwriter's Laboratories, Inc. (UL),
24 ETL, or Canadian Standards Association.

25 **PART 2 – PRODUCTS**

26 **2.01 GENERAL**

- 27 A. The grounding system shall consist of grounding conductors, ground bus, ground fittings
28 and clamps, and bonding conductors to equipment and structural steel as shown on the
29 Drawings or as required to meet the requirements of the NEC.

1 **2.02 SYSTEM COMPONENTS**

2 A. Ground Conductors:

- 3 1. Conductors shall be soft drawn copper.
- 4 2. Sizes over #6 AWG shall be stranded.
- 5 3. Coat ground connections with electrical joint compound, nonpetroleum type, listed for
6 copper and aluminum applications.
- 7 4. Provide ground conductors with either green colored insulation or uninsulated bare
8 copper unless noted otherwise in the Contract Documents.
- 9 a. Buried ground conductors shall be bare copper.
- 10 5. If cable sizes are not specified, the minimum sizes shall be as follows unless otherwise
11 specified on the Drawings:
- 12 a. Service Entrance Disconnect Switch: 2 AWG
- 13 b. Lighting Panels: 4 AWG
- 14 c. Exposed Metal: 2 AWG
- 15 d. Control Panels: 12 AWG

16 B. Ground Connections:

- 17 1. Binding Post Connectors:
- 18 a. Lugs for attachment of cables to steel enclosures shall be of the binding post type
19 with a 1/2-13 NC stud.
- 20 b. Each post shall accommodate cables from #4 AWG to #4/0 AWG.
- 21 2. Compression Connectors:
- 22 a. Material-pure wrought copper extrusions.
- 23 b. Irreversible compression connection.
- 24 c. Acceptable Manufacturer:
- 25 1) Thomas and Betts.
- 26 2) Burndy.
- 27 3) Approved equal.

- 1 3. Bolted Connectors:
- 2 a. Acceptable Manufacturer:
- 3 1) Burndy.
- 4 2) O. Z. Gedney.
- 5 3) Approved equal.
- 6 4. Exothermic Welding:
- 7 a. Exothermic welding for bonding connections is acceptable for
- 8 below-grade connections.
- 9 C. Ground Rods:
- 10 1. Copper covered steel, 3/4-inch diameter and 10 feet long.
- 11 2. Rods shall have threaded type removable caps so that extension rods of the same
- 12 diameter and length may be added where necessary.
- 13 D. Ground Rod Test Wells:
- 14 1. Test well shall be 12-inch diameter concrete well with cast iron cover.
- 15 2. Traffic rated for H-20 vehicle traffic.
- 16 3. Cover shall have the word "GROUND" visible and shall be permanent to the cover.
- 17 E. Ground Connector for Enclosure:
- 18 1. Ground dual-rated mechanical connector for two conductors and one-hole mount.
- 19 a. For copper and aluminum conductors.
- 20 b. Tin-plated for low contact resistance.
- 21 c. All aluminum bodies.
- 22 d. Conductor range (AWG): #14 to #2/0 str.
- 23 2. Ground Connector shall be UL Listed.
- 24 3. Manufacturer ABB-Blackburn Mechanical Connectors Cat. No. ADR21-21 or equal.
- 25 F. Ground Connector for Equipment Racks:
- 26 1. Long barrel, one-hole, and time plated ground lug.
- 27 2. Sized for #2/0 ground conductor.

- 1 3. For 3/8 inch ground stud.
- 2 4. Lug shall be UL Listed.
- 3 5. Manufacturer Burndy Cat, No. YA26 or equal.
- 4 G. Ground bar for Enclosure:
- 5 1. Provide ground bar inside the following enclosures:
- 6 a. Pump Control Panel (PCP-106).
- 7 b. Pump Termination Panel (TP-1).
- 8 2. Copper or tin-plated copper.
- 9 3. Dimensions:
- 10 a. 4" L X 1"W X 0.25" D.
- 11 4. Two fastening holes at each end for mounding.
- 12 5. Five paired holes for terminating grounds.
- 13 6. Acceptable manufacturer Saginaw Control and Engineering Part Number SCE-GB10
- 14 or approved equal.

15 **PART 3 – EXECUTION**

16 **3.01 INSTALLATION**

- 17 A. Connection methods:
- 18 1. Provide irreversible compression ground connectors for all ground
- 19 bonding connections.
- 20 a. Buried ground conductors.
- 21 b. Equipment racks grounding conductor.
- 22 c. Pump Control Panel (PCP-106) chassis ground connection to buried
- 23 ground conductors.
- 24 d. Generator frame grounding conductor.
- 25 B. Ground electrode conductor. Where grounding conductors pass through concrete floors,
- 26 equipment pads, or wall, provide PVC conduits for grounding conductors to pass through.
- 27 1. Except where grounding conductors are bonding to reinforcement steel within
- 28 the concrete.

- 1 C. Ground equipment for which a ground connection is required per NEC whether or not the
- 2 ground connection is specifically shown on the Drawings.
- 3 D. Prior to making ground connections or bonds, clean metal surface at the point of connection.
- 4 E. Ground rod spacing – ground rods shall not be located within 10 feet of each other.

5 **3.02 RACEWAY GROUND**

6 A. Metallic Conduits:

- 7 1. Assembled to provide a continuous ground path and bonded using insulated
- 8 grounding bushings.
- 9 2. Bond using insulated grounding bushings.

10 B. Non-Metallic Conduits: Insulated ground conductor sized in compliance with the NEC.

11 C. Grounding Bushings: Connected to the grounding system using conductors sized in

12 compliance with NFPA 70.

13 D. Provide a ground wire in every conduit carrying a circuit of over 50 V to ground.

14 **3.03 GROUND ELECTRODES**

15 A. Provide ground electrodes as specified in this section or on the Drawings.

16 **3.04 EQUIPMENT AND ENCLOSURE GROUND**

17 A. Connect electrical and distribution equipment to the grounding system. Cables sized as

18 shown on the Drawings or specified in this section.

19 **END OF SECTION**

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1 **SECTION 26 05 29**

2 **HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

3 **PART 1 – GENERAL**

4 **1.01 SECTION INCLUDES**

- 5 A. This section specifies the furnishing of installation of hangers and supports for electrical
6 systems as indicated on the Contract Drawings and herein specified.

7 **1.02 REFERENCE STANDARDS**

- 8 A. This section incorporates by reference the latest revision of the following documents.
9 These references are a part of this section as specified and modified. In case of conflict
10 between the requirements of this section and those of the listed documents, the
11 requirements of this section shall prevail.

- 12 1. ASTM A123: Standard specification for zinc coatings on iron and steel.
13 2. ASTM A193/A193M REV C: Alloy-steel and stainless-steel bolting materials for
14 high-temperature service.
15 3. NFPA 70: National Electrical Code (NEC).

16 **1.03 SUBMITTALS**

- 17 A. Shop Drawings: Submit product information/data shop drawings for materials in
18 accordance with Section 26 05 11, "Basic Electrical Methods and Materials."
19 B. Include manufacturer's product information including catalog cuts.
20 C. Submit operation and maintenance manuals as specified in Section 26 05 11, "Basic
21 Electrical Methods and Materials."
22 D. Submit attachment details for any new support connections to the existing structure.

23 **1.04 SEISMIC SUPPORT**

- 24 A. Mechanical, instrumentation and control, electrical, nonstructural systems, components,
25 and elements permanently attached to the structure shall be anchored and braced to resist
26 seismic forces. Contractor shall design the structural components, seismic attachment,
27 braces, and anchors to the structure for all parts or elements of the mechanical and
28 electrical systems in accordance with Section 13 05 41.

29 **1.05 WARRANTY**

- 30 A. Contractor shall ensure electrical equipment warranty shall begin after significant
31 completion of construction.
32 B. This warranty is applicable for hangers and supports of electrical equipment installed,
33 tested, and commissioned during that phase.

1 **PART 2 – PRODUCTS**

2 **2.01 GENERAL FASTENING AND SUPPORT HARDWARE**

3 A. Provide fasteners, anchors, clamps, supports, strut, rod, plates, posts, and brackets made
4 of the following material in the identified area:

5 1. Exterior areas – Hot dipped galvanized.

6 2. Within the wet wells, vaults, corrosive, and underwater locations, unless otherwise
7 specified, shall be minimum 304 Stainless Steel.

8 a. Bolts: shall be ASTM A193 Grade B8, Class 2 Stainless Steel, AISI 304.

9 b. Nuts: shall be ASTM A194 Grade 8 Stainless Steel, AISI 304.

10 B. Expansion shield and tamperproof pin style anchors are not acceptable. Size anchors to
11 meet load requirements. Minimum size anchor bolt is 3/8 inch.

12 C. All equipment fasteners and anchors shall be reversible to allow equipment to be removed
13 or replaced.

14 D. All conduit supports shall include braces for seismic loadings.

15 **2.02 RACEWAY SUPPORTS**

16 A. Conduit Supports:

17 1. Provide strut channel with end caps to support groups of conduits.

18 2. Individual conduit supports shall be one-hole pipe straps used with clamp backs and
19 nesting backs where required.

20 **PART 3 – EXECUTION**

21 **3.01 GENERAL**

22 A. Treat ferrous metal exposed male threads, cut surfaces, and damaged ends with
23 corrosion-resistant coatings, such as “Zinc-It” prepared by CRC, “Crown Premium 7007”
24 prepared by L. H. Dottie, or “Devcon Z” prepared by ITW Polymers & Fluids, or approved
25 equal. Application shall follow manufacturer’s recommendation.

26 **3.02 SUPPORT LOCATIONS**

27 A. Locate at least one support within 2 feet from a conduit change in direction, change in
28 elevation, adjacent to flexible joints and couplings, and where shown on the Drawings.

29 B. Locate a vertical conduit support within 1 foot above each floor/slab penetration or grade.

30 C. Locate supports to ensure that connections to equipment, panels, etc., are substantially
31 free from loads transmitted by the conduit.

- 1 D. Conduit supports shall not be placed at a location which will cause interference with the
2 operation of equipment or other items that need to be accessed for regular operation and
3 maintenance of the facility. Do not install conduit supports and hangers in equipment
4 access areas.
- 5 E. Maximum Support spacing shall not exceed 4 feet for PVC and any other non-metallic
6 piping systems. Support spacing shall not exceed 6 feet for metal conduit systems unless
7 otherwise approved by the Engineer.

8 **3.03 INSTALLATION**

- 9 A. Conduit support brackets, etc. shall be of suitable capacity and shall be appropriate to the
10 individual structural member used to support the conduit.
- 11 B. Conduit may be supported from the nearest structural element (ceiling, wall) as long as
12 these attachments shall not cause the structural member to exceed the design live load
13 criteria shown on the Drawings.
- 14 C. Do not support any conduit from any piping supports.
- 15 D. Brace hanging conduit against horizontal movement by both longitudinal and lateral sway
16 bracing.
- 17 E. Install lateral supports for seismic loads at all changes in direction and where conduit
18 support does not provide adequate lateral support for tributary seismic loads.
- 19 F. Install supports to allow controlled thermal and seismic movement of conduit systems, to
20 permit freedom of movement between conduit support anchors, and to facilitate action of
21 expansion joints and similar units.
- 22 G. Repair mounting surfaces to original condition after attachments are made.
- 23 H. Strut System Installation: Arrange for grouping of parallel runs of conduit and support
24 together on field-assembled struts.
- 25 I. Prior to grouting, rough finished floor beneath structural attachments and framing channel
26 post bases. Grout between base plate and floor shall be free of voids and foreign material.
- 27 J. Provide plastic or rubber end caps at the exposed ends of all framing channels that are
28 located up to 7 feet above the floor or grade.

29 **3.04 ANCHOR BOLTS**

- 30 A. Anchor bolt material and installation requirements shall conform to Specification
31 Section 13 05 41.

32 **END OF SECTION**

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1 **1.05 SHIPPING, STORAGE, AND HANDLING**

- 2 A. Contractor shall ensure electrical equipment received is stored in a dry, secured, safe
3 location, protected for water, rain, dirt, construction debris, and physical damage.
- 4 B. Contractor is responsible for electrical equipment until the equipment has been
5 commissioned and successfully demonstrated to the Owner.

6 **PART 2 – PRODUCTS**

7 **2.01 GENERAL**

- 8 A. Provide conduit system of the types of conduit as indicated in the Conduit Usage Schedule
9 in Part 3 of this section.
- 10 B. Provide minimum of 1-inch trade-size conduit.
- 11 C. Both 90-degree short radius and 90-degree large radius adapter elbows are prohibited.
- 12 D. Provide junction boxes as necessary to facilitate pulling and/or splicing of wires.
- 13 E. All equipment fasteners and anchors shall be reversible to allow equipment to be removed
14 or replaced.

15 **2.02 METAL CONDUIT AND FITTINGS**

- 16 A. Galvanized Rigid Steel Conduit (GRS) and Fittings:
- 17 1. Conduit: Comply with ANSI C80.1 and UL 6 standards.
- 18 2. Fittings: Comply with UL 514B and NEMA FB1 and FB2.10 standards.
- 19 3. Hot-dip galvanized steel.
- 20 4. Couplings shall be threaded type. Setscrew-type and compression-type are
21 not acceptable.
- 22 5. Union couplings for conduits shall be the three-piece (Erickson) type. Threadless
23 couplings shall not be used.

24 **2.03 RIGID NONMETALLIC CONDUIT AND FITTINGS**

- 25 A. Polyvinyl Chloride Conduit (PVC) and Fittings:
- 26 1. Conduit: Comply with NEMA TC2 and UL 651 standards.
- 27 2. Fittings: Comply with NEMA TC3 and UL 641 standards.
- 28 3. Joints shall be made with standard PVC Couplings.
- 29 4. Fittings shall be PVC solvent weld type.

- 1 5. PVC conduit shall have bell ends where terminated at walls and boxes.
- 2 6. PVC40 – Schedule 40, high-impact polyvinyl chloride conduit.
- 3 7. PVC80 – Schedule 80, high-impact polyvinyl chloride conduit.
- 4 8. No PVC conduit elbows, no PVC field bends; all elbows are factory RTRC.

5 **2.04 FLEXIBLE CONDUIT AND FITTINGS**

6 A. Liquidtight Flexible Metal Conduit and Fittings:

- 7 1. Conduit: Comply with UL 360 standards.
 - 8 a. Galvanized flexible steel core.
 - 9 b. Provide outer liquidtight, PVC sunlight resistant jacket.
- 10 2. Fittings: Comply with UL 514B and NEMA FB1 standards.
- 11 3. Liquidtight Flexible Metal Conduit shall not be used in corrosive locations.

12 B. Liquidtight Flexible Nonmetallic Conduit and Fittings:

- 13 1. Conduit: Comply with UL 1660 standards.
- 14 2. Fittings:
 - 15 a. Shall comply with UL 514B and NEMA FB1 standards.
 - 16 b. Shall be Arlington NMLT three-piece connectors.

17 **2.05 CONDUIT BODIES**

18 A. Metallic Conduit Bodies: Comply with ANSI C80.4 and C33.84, and UL 514 standards.

- 19 1. Use hot-dipped galvanized or cadmium plated malleable iron, or copper-free
20 aluminum material.

21 B. Contractor shall provide conduit bodies which support the NEC conductor bend radius.
22 Contractor shall provide large-bend radius conduit bodies or provide larger size conduit
23 bodies to be in compliance with conductor bend radius.

24 C. Provide removable cover with gasket and corrosion-resistant screws.

25 D. Contractor shall show location for fiberglass conduit bodies on shop drawings and obtain
26 Owner approval of location prior to installation.

27 **2.06 CABLE GLAND CONNECTORS**

28 A. Cable gland shall be for nonarmored cables.

- 1 B. Cable glands shall be:
- 2 1. Metal glands list for area classification in which they are installed.
- 3 2. Stainless Steel and NEMA 4X for process areas.
- 4 3. UL Listed.
- 5 4. Suitable for use in wet locations.
- 6 5. Rugged, durable construction protection of cords and cables from damage.
- 7 a. Provide Stainless Steel wire mesh grips when needed for strain relief.
- 8 b. Standard neoprene bushing weatherproof seal on outer sheath of cable.
- 9 6. Operating temperatures: -25°C to +40°C.

10 C. Acceptable manufacturers:

- 11 1. Eaton (Crouse Hinds).
- 12 2. Emerson (Appleton).
- 13 3. Or preapproved equal.

14 **2.07 INNERDUCT**

15 A. Provide fabric-type innerduct for fiber optic communication conduits.

16 B. Fabric-type innerduct shall have a minimum number of cells:

- 17 1. For 1-inch conduit, provide a minimum of two-cell fabric-type innerduct.
- 18 2. For 1.5-inch to 2.5-inch conduit, provide a minimum of three-cell fabric-type innerduct.
- 19 3. For 3.0-inch conduit and larger, provide a minimum of four-cell fabric-type innerduct.

20 C. Fabric innerduct shall be:

- 21 1. Halogen-Free.
- 22 2. Resistant to ground chemicals and petroleum products.
- 23 3. Constructed of PET (Polyethylene Terephthalate) and Nylon 6.
- 24 4. Shall include preinstalled 600 lb. glide rope in each cell.

25 D. Acceptable manufacturers:

- 26 1. MaxCell.
- 27 2. Or preapproved equal.

1 **2.08 DRAINS AND BREATHERS**

2 A. Automatic Drain-Breather:

- 3 1. Use Crouse-Hinds or Appleton Type ECD or approved equal.
4 2. Use Appleton Type CRN (nonhazardous locations) or approved equal.

5 B. Condensate Drain:

- 6 1. Use conduit outlet body, Type T.
7 a. Provide threaded, galvanized plug with 3/16-inch drilled hole through plug.

8 **2.09 CONDUIT PENETRATIONS**

- 9 A. Enclosures: Provide zinc Myers hub with Viton O-ring and Lexan insuliner (by
10 Cooper Crouse-Hinds or approved equal) for termination of conduits to enclosures.
11 Provide ground nut as required.

12 **2.10 OUTLET BOXES AND JUNCTION BOXES**

- 13 A. Junction boxes in process areas and as specified on Drawings shall be NEMA 4X.

- 14 B. Flush Mounted: Provide hot-dipped galvanized steel boxes and accessories suitable for
15 application and type construction.

- 16 C. Surface Mounted: Provide corrosion-resistant single or multiple gang malleable iron
17 Type FS or FD cast boxes with threaded hubs, or pressed steel boxes as permitted under
18 Part 3 of this section.

- 19 1. Aluminum FS or FD boxes are not allowed.

- 20 D. Weatherproof Boxes: Provide gasketed covers and corrosionproof fasteners.

21 E. Cast Metal Boxes:

- 22 1. Box bodies and cover shall be cast or malleable iron with a minimum wall thickness of
23 1/8 inch at every point, and not less than 1/4 inch at tapped holes for rigid conduit.
24 Bosses are not acceptable.

- 25 2. Mounting lugs shall be provided at the back or bottom corners of the body.

- 26 3. Covers shall be secured to the box body with No. 6 or larger brass or bronze
27 flathead screws.

- 28 4. Boxes shall be provided with neoprene cover gaskets.

- 29 5. Where only cast aluminum is available for certain types of fixture boxes, an epoxy
30 finish shall be provided.

1 6. Outlet boxes shall be of the FS types. Boxes shall conform to FS W-C-586C, UL 514A,
2 and UL 514C.

3 F. Pull Boxes and Junction Boxes:

4 1. Boxes shall be fabricated from carbon steel per UL 50 with the following exception:

5 a. Boxes specified on Drawings as NEMA 4X shall be stainless steel with hinged and
6 padlock cover.

7 2. Boxes shall be welded construction with seams or joints closed and reinforced.

8 3. Galvanized boxes damaged during construction shall have shall be galvanized
9 after construction.

10 4. Boxes intended for outdoor use shall be cast metal with threaded hubs and neoprene
11 gasketed covers. Cover retention shall be by corrosion-resistant stainless-steel screws.

12 5. Boxes and cabinets shall be securely fastened to equipment rack structural members
13 so as to prevent movement in any direction. Boxes shall not be supported by lighting
14 fixtures, suspended ceiling support wires, or freely hanging rods.

15 a. Covers of boxes and cabinets mounted in horizontal plane (top or bottom) either
16 shall weigh not more than 40 pounds or shall require not more than 40 pounds of
17 force to open or close.

18 b. Covers of boxes and cabinets mounted in vertical plane (front, back, sides) either
19 shall weigh not more than 60 pounds or shall require not more than 60 pounds of
20 force to open or close. Covers over 30 pounds shall be furnished with angle
21 support at bottom to carry weight of cover for assembly.

22 c. Covers of boxes and cabinets weighing more than 30 pounds shall be provided
23 with lifting handles or some means of grasping other than edges.

24 G. Terminal Box Enclosures (including Termination Panels):

25 1. Provide enclosure for terminal box as follows:

26 a. NEMA 4X rated enclosure fabricated from 14-gauge type 304 stainless steel with
27 welded seams ground smooth.

28 b. Body and door stiffeners for added rigidity.

29 c. Continuous hinged door with gasket seal.

30 1) Hinged door shall have provisions for padlocking closed.

31 d. Rolled lip around three sides of door and all sides of enclosure opening to exclude
32 liquids and contaminants.

33 e. Door sealed with polyurethane gasket.

- 1 f. Collar studs for mounting back panel.
- 2 g. External mounting feet.
- 3 h. Grounding provisions provided including stud located on door.
- 4 i. Enclosure size as shown on the Drawings.
- 5 j. Back panel: type 304 stainless steel.
- 6 k. Provide Aluminum DIN Rail Mounts for Terminal Blocks.
- 7 l. Contractor to provide shop drawings depicting the interior terminal box enclosure
- 8 components and their layout arrangement.
- 9 1) Terminal Box Enclosures which contain power wiring, control wiring,
- 10 signal wiring shall have physical separation between the power, control, and
- 11 signal wiring types. Contractor shall use wire management devices
- 12 (clamps, troughs, and plastic ties, etc.) to physically separate wire types within
- 13 enclosure.
- 14 2) Contractor to depict the size of the enclosure to allow space for internal wiring
- 15 while maintaining wire separations. Submit terminal box enclosure size.
- 16 3) Contractor shall submit shop drawing depicting the interior components
- 17 configuration and arrangement.
- 18 4) Contractor shall size enclosure to fit space on wall as shown on the Drawings.
- 19 Contractor shall rework existing conduit/wiring if required to place new Terminal
- 20 Box Enclosure on wall.
- 21 m. Acceptable Manufacturers:
- 22 1) Wiegmann.
- 23 2) Saginaw Control and Engineering.
- 24 3) Approved equal.
- 25 a) Example of a Wiegmann enclosure with back panel: catalog
- 26 number SSN4363612, with Back Panel catalog number NP3636SS).
- 27 H. Terminal Blocks:
- 28 1. Provide terminal blocks for terminal box as follows:
- 29 a. Feed through terminal blocks, DIN Rail mounted.
- 30 b. Rating: 600 V, 30 A.
- 31 c. UL Listed.
- 32 d. Wire Size: 22-10 AWG.

- 1 e. Provide perforated jumper bar as follows:
- 2 1) Current rating 32 A.
- 3 2) Perforated jumper bar rated for use with terminal blocks.
- 4 3) Cut to length.
- 5 4) Provide subassembly screw and post.
- 6 f. Provide Separator, End Sections, and End Stops as required.

7 **2.11 PULL BOXES AND SPECIAL PURPOSE OUTLET BOXES**

- 8 A. Provide pull boxes with covers held in place by corrosion-resistant machine screws, and
- 9 of type or NEMA rating as shown on the Drawings.
- 10 B. Provide special purpose outlet boxes furnished with fixtures and devices where standard
- 11 outlets are not applicable.

12 **2.12 ANTICORROSION PROTECTION TAPE**

- 13 A. Provide anticorrosion protection tape around galvanized rigid steel conduit passes through
- 14 concrete. Outdoors, no galvanized rigid steel conduit shall be in direct contact with
- 15 concrete where conduit penetrates into concrete wall, floor, ceiling, slab, or etc.
- 16 B. Anticorrosion protection tape shall be:
- 17 1. Minimum thickness of 10 mils.
- 18 2. Minimum of 2 inches wide.
- 19 3. Maximum temperature rating of 176°F.
- 20 4. UV resistant.
- 21 5. Listed for protecting conduits and fittings.
- 22 6. Listed for impact and abrasion resistance.
- 23 7. Used for early-warning protection of digging around reinforced concrete duct banks.
- 24 C. Acceptable manufacturers: 3M Scotchrap All-Weather Corrosion Protection Tape or
- 25 approved equal.

26 **2.13 HAZARDOUS LOCATION SEALING FITTINGS**

- 27 A. Comply with UL 886 standard.
- 28 B. Use malleable iron, zinc plated, or copper-free aluminum fittings.
- 29 C. Fittings shall allow 40% wire fill.

1 D. Provide fiber packing and sealing compound from same manufacturer as fittings.

2 **PART 3 – EXECUTION**

3 **3.01 INSTALLATION – RACEWAY**

4 A. Provide furnishing for the installation of hangers and supports as specified in
5 Section 26 05 29.

6 B. Conduit routed into wet well, meter vault, and valve vault shall be PVC Schedule 80.

7 1. Where manufacturer's cables are used, PVC conduit shall have PVC end bell fitting to
8 protect wiring.

9 C. Conduit stubbed-up 6 inches for air gap underneath termination panels shall be PVC
10 Schedule 80. Stubbed-up conduit shall have PVC end bell fitting to protect wiring.

11 D. Provide all spare raceways with 1/2-inch woven polyester pull tape with foot marks.

12 E. Install conduit and fittings in accordance with manufacturer's recommendations.

13 F. Run exposed conduits parallel to or at right angles with lines of building or structure.

14 G. Keep conduit plugged, clean, and dry during construction.

15 H. Conduit runs extending through areas of different temperature or atmospheric conditions,
16 or partly indoors and partly outdoors must be sealed, drained, and installed in a manner
17 preventing drainage of condensed or entrapped moisture into cabinets, boxes, fixtures,
18 motors, or equipment enclosures. The wall, ceiling and/or floor penetrations associated
19 with these conduit runs shall be sealed using a link-seal or equivalent sealing method
20 approved by the Engineer.

21 I. Conduits Run in Concrete Structures:

22 1. Comply with applicable provisions of ACI 318 for conduits embedded in structural
23 frame slab.

24 2. Install conduits parallel to each other spaced on center of at least three times conduit
25 trade diameter with minimum 2-inch concrete covering.

26 3. Conduits over 1-1/2 inches may not be installed in slab without approval of Engineer.

27 4. Apply anticorrosion tape to galvanized rigid steel conduits run or penetrated
28 into concrete.

29 a. Anticorrosion tape shall be applied per the manufacturer instructions.

30 J. Install bushings with ground lugs and integral plastic linings at equipment with
31 open-bottom conduit entrances.

- 1 K. Exterior Underground Conduit: Provide conduits or ducts terminating below grade with
2 means to prevent entry of dirt or moisture. Provide conduit threaded coupling and threaded
3 plug to protect conduit from debris.
- 4 L. Immediately upon completion of pouring concrete, thoroughly swab conduits on the inside.
5 After the concrete has set, and before backfilling, pull a mandrel having a diameter equal
6 to the nominal conduit inside diameter minus 1/2 inch and not less than 4 inches long,
7 through each conduit. If the mandrel shows signs of protrusions on the inside of the
8 conduit, repair or replace the conduit.
- 9 M. Outdoor underground conduit shall be sloped to drain toward manholes or vaults
10 where applicable.
- 11 N. Flexible conduit shall be limited to 36 inches in length and used for vibration isolation or
12 where equipment requires flexible connections.
- 13 O. Conduits from classified spaces (wet well, meter vault, valve vault, etc) do not require seal
14 fittings if conductors from classified spaces pass through the Pump Termination Panel
15 and air gap.
- 16 1. If conduit and wiring from classified spaces do not pass through the Pump Termination
17 Panel and air gap then seal fittings are required.

18 **3.02 INSTALLATION – BOXES**

- 19 A. Install boxes in accordance with manufacturer's recommendations.
- 20 B. Use weatherproof boxes for exterior locations exposed to weather or moisture.
- 21 C. Do not install boxes back to back.
- 22 D. Set outlet boxes parallel to construction.
- 23 E. Thoroughly clean boxes prior to installing wiring devices.

24 **3.03 CUTTING AND PATCHING**

- 25 A. Core drill through reinforced concrete with approval of Owner.
- 26 B. Cut and patch in accordance with the following:
- 27 1. Surface Conditions:
- 28 a. Inspection:
- 29 1) Inspect existing conditions, including elements subject to movement or
30 damage during cutting, excavating, patching, and backfilling.
- 31 2) After uncovering the work, inspect conditions affecting installation of new work.

- 1 b. Discrepancies:
- 2 1) If uncovered conditions are not as anticipated, immediately notify the Owner
- 3 and obtain needed directions.
- 4 2) Do not proceed until unsatisfactory conditions are corrected.
- 5 2. Preparation Prior to Cutting: Provide required protection including, but not necessarily
- 6 limited to, shoring, bracing, and support to maintain structural integrity of the Work.
- 7 3. Performance:
- 8 a. Perform required excavating and backfilling as required under pertinent other
- 9 sections of these specifications.
- 10 b. Perform cutting and demolition by methods which will prevent damage to other
- 11 portions of the Work and provide proper surfaces to receive installation of repair
- 12 and new work.
- 13 c. Perform fitting and adjusting of products to provide finished installation complying
- 14 with the manufacturer's recommendations for specified equipment, products,
- 15 tolerances, and finishes.
- 16 d. Perform slight alterations needed to make adjustable parts fit to fixed parts to
- 17 provide a complete installation.
- 18 e. Refinish surfaces as necessary to match adjacent finishes.

19 **3.04 RESTRICTIONS**

- 20 A. Do not route exposed conduit below and parallel to, or adjacent to water piping.
- 21 B. Do not splice power wires, control/instrumentation wires/cables, or fiber optic cables
- 22 except where otherwise permitted on Drawings.

23 **3.05 EXISTING CONDUIT**

- 24 A. The Drawings do not show the location of existing conduit as indicated by available
- 25 existing records. The proposed work may require crossing, relocating, and, in some cases,
- 26 connecting to the existing conduits.
- 27 B. Expose carefully the existing conduits throughout the area of proposed work.
- 28 1. Existing conduits to remain undisturbed and in uninterrupted use until such time as a
- 29 change is approved by the Engineer.
- 30 C. Where the conduits are to cross or be connected to existing conduit, make a field check
- 31 to determine whether any conflict will be encountered in laying the new conduit.
- 32 1. Adjust the location of new conduits, if necessary, as authorized by the Engineer, to
- 33 avoid conflict with existing conduits.

- 1 D. Where new conduits are to connect to existing conduits, provide fittings required to
2 complete the connection, and do the work as expeditiously and carefully as possible.
- 3 1. Inspect and clean existing conduit prior to installing new wire.
- 4 E. Remove and replace existing conduits, fittings, boxes, and appurtenances as shown on
5 the Drawings.
- 6 1. Do not remove and replace existing items shown to remain unless approved by
7 the Engineer or specified on the Drawings.

8 **3.06 CONDUIT USAGE SCHEDULE**

- 9 A. Install GRS in the following locations unless otherwise shown on the Drawings:
- 10 1. Concealed in poured concrete walls and floor or roof slabs.
- 11 2. Exposed.
- 12 B. Install PVC in underground conduits are not exposed to physical damage and in the wet
13 well and vaults.
- 14 C. Install liquidtight flexible conduit and fittings for connections to instrumentation and
15 equipment subject to vibration and at locations shown on the Drawings.
- 16 1. For corrosive or outdoor environments, install liquidtight flexible nonmetallic conduit
17 and fittings.
- 18 2. Liquidtight flexible nonmetallic conduit to be no greater than 36 inches in length in any
19 situation unless prior written approval is provided by the Engineer.

20 **3.07 EXPOSED OUTLET AND JUNCTION BOXES**

- 21 A. Use cast boxes unless noted otherwise on the Drawings.
- 22 B. Install weatherproof outlet, switch, and junction boxes outdoors and in any area where
23 Drawings show weatherproof (WP) wiring devices.

24 **3.08 OUTLET BOX ACCESSORIES**

- 25 A. Provide outlet box accessories and mounting devices as required for each installation.

26 **3.09 OUTLET BOX LOCATIONS**

- 27 A. Location of outlets and equipment is approximate. Exact location to be verified and
28 determined by:
- 29 1. Conflict with equipment of other trades.
- 30 2. Equipment manufacturer's drawings.
- 31 3. Owner in field.

1 B. Minor modification in location of outlets and equipment is considered incidental up to
2 distance of 10 feet with no additional compensation, providing necessary instructions are
3 given prior to roughing-in of outlet boxes and equipment.

4 C. Mounting Heights:

5 1. Locations of wall outlets shall be measured from the finished floor to the center of the
6 outlet box. Boxes shall be adjusted so that the front edge of the box shall not be further
7 back from the finished wall plane than 1/4 inch. Boxes shall be adjusted so that the
8 box does not project beyond the finished wall. Height above finished floor (AFF) or
9 above finished grade (AFG) shall be as follows unless noted otherwise:

10 a. Receptacles – Industrial Areas: 36 inches AFF or AFG.

11 b. Toggle or Timer Switches: 48 inches AFF or AFG.

12 **3.10 INSTALLATION**

13 A. Outlet Boxes:

14 1. Provide fixture outlets with proper fixture connectors.

15 2. Box mounting height shall be dictated by the wiring device enclosed.

16 3. Blanking covers shall be installed on unused openings.

17 4. Cast metal surface-mounted boxes shall be used in exterior and/or in wet locations.

18 5. Bonding jumpers shall be used around concentric or eccentric knockouts.

19 6. Boxes shall be securely mounted to structure (i.e. equipment racks) independent of
20 conduits entering or exiting the boxes.

21 B. Junction Boxes and Pull Boxes:

22 1. Boxes shall be installed where required and where indicated on the Drawings.

23 2. Boxes shall be readily accessible.

24 3. Box dimensions shall be in accordance with size and quantity of conductors and
25 conduits entering and leaving box per NEC Article 370 requirements.

26 **END OF SECTION**

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- 1 c. Length as required.
- 2 d. 1/16-inch thick.
- 3 e. UV and scratch resistant.
- 4 4. Lettering: 1/4-inch-high lettering for equipment name and tag number.
- 5 5. Nameplate text shall include:
 - 6 a. Line 1: Asset number (e.g., "P2-040").
 - 7 b. Line 2: Descriptive tag (e.g., "Effluent Pump #1").
 - 8 c. Line 3: Associated MCC (e.g., "MCC2A").
 - 9 d. Line 4: Voltage (e.g., "480 volts").
- 10 C. Nameplate schedule shall be included with equipment submittals.

11 **2.02 RACEWAY/CONDUIT MARKERS**

- 12 A. Provide raceway/conduit markers for new and unlabeled raceways and conduits within the
13 project boundary.
- 14 B. Provide raceway/conduit markers.
 - 15 1. 316 Stainless steel.
 - 16 2. Minimum dimensions: 1-inch by 3-inch by 18-gauge thick.
 - 17 3. Two holes at each end for wire attachment.
 - 18 4. Lettering: 1/4-inch tall, laser etched with black fill.
 - 19 5. Attach with 316 stainless steel wire, 16 AWG minimum.

20 **2.03 PERMANENT WIRE MARKERS**

- 21 A. Wire markers shall be heat shrink type (Raychem, T&B, or approved equal), or
22 self-laminating where conductors are not spliced or terminated. Wire numbers shall be
23 permanently imprinted on the markers.

1 **PART 3 – EXECUTION**

2 **3.01 GENERAL**

- 3 A. Label electrical and control equipment associated within scope of work.
- 4 B. Equipment containing power distribution equipment 120 V and greater shall have
5 nameplates identifying source of power equipment identification asset number and
6 its location.

7 **3.02 RACEWAY/CONDUIT MARKERS**

- 8 A. Neatly attach marker to the raceway with 316 stainless steel wire.
- 9 B. Exposed Conduit:
- 10 1. Marker shall be placed within 24 inches of termination or wall penetration.
- 11 2. A single marker will be allowed when the entire length of conduit is clearly visible from
12 one location.
- 13 C. In concrete vaults with conduit flush with wall, attach markers to concrete with stainless
14 steel hardware. Markers to be located within 6 inches of conduit. This applies to both
15 existing and new conduits in vaults.
- 16 D. Attach nameplate to equipment with mechanical fastening means.
- 17 E. Locate label inside vault where easily seen from surface with cover removed.

18 **3.03 LOW-VOLTAGE WIRE AND CABLE IDENTIFICATION**

- 19 A. Except for interior lighting and receptacle circuits, identify each wire or cable at each
20 termination and in each pull box, junction box, handhole, and manhole using numbered
21 and lettered wire markers. Electrically common conductors shall have the same number.
22 Each electrically different conductor shall be uniquely numbered. Identify panelboard
23 circuits using the panelboard identification and circuit number. Identify motor control
24 circuits using the equipment identification number assigned to the control unit by the motor
25 control center manufacturer and the motor control unit terminal number. Identify other
26 circuits as shown in the circuit schedule or as favorably reviewed by the Engineer.
- 27 B. Conductors between terminals of different numbers shall have both terminal numbers
28 shown at each conductor end. The terminal number closest to the end of the wire shall be
29 the same as the terminal number.
- 30 C. Provide schedule identifying various power and lighting conductors from power source to
31 equipment or device served.

- 1 D. Color Coding:
- 2 1. Provide color coding for circuit conductors. Conductors #6 and smaller shall be of
3 appropriate color for the entire length. Insulation color shall be green for grounding
4 conductors. Current carrying conductor colors shall be as follows:
- 5 a. 240/120 V, Three-Phase, Power: (A) Black, (B) Orange, and (C) Blue,
6 and (N) White.
- 7 b. 120 V, Control: Multicolor.
- 8 2. Provide appropriate color-coding electrical tape at terminations on conductors without
9 continuous color-coded insulation. Conductor colors shall be as listed above.

10 **3.04 SIGNAL CABLE IDENTIFICATION**

- 11 A. Identify each wire or cable at each termination, in each pull box, and in each handhole
12 using numbered and lettered wire markers. Electrically common conductors shall have the
13 same number. Each electrically different conductor shall be uniquely numbered. Identify
14 panelboard circuits using the panelboard identification and circuit number. Identify motor
15 control circuits using the equipment identification number assigned to the control unit by
16 the motor control center manufacturer and the motor control unit terminal number. Identify
17 other circuits as shown in the circuit schedule or as favorably reviewed by the Engineer.
- 18 B. Conductors between terminals of different numbers shall have both terminal numbers
19 shown at each conductor end. The terminal number closest to the end of the wire shall be
20 the same as the terminal number.

21 **END OF SECTION**

1 **SECTION 26 05 73**

2 **SHORT CIRCUIT, COORDINATION, AND ARC FLASH REPORT**

3 **PART 1 – GENERAL**

4 **1.01 SECTION INCLUDES**

5 A. Provide the services of a recognized independent testing laboratory or coordination
6 analysis consultant (Consultant) to provide the following power study reports:

- 7 1. Short Circuit Report.
8 2. Protective Device Coordination Report.
9 3. Arc Flash Report.

10 B. Contractor shall use the electrical distribution and loads as specified on the Drawings to
11 the electrical model to prepare the new reports.

12 C. The work of the following sections is related to the work of this section. Other sections, not
13 referenced below, may also be related to the proper performance of this work. It is the
14 Contractor’s responsibility to perform all the work required by the Contract Documents.

- 15 1. Section 26 05 11, “Basic Electrical Methods and Materials.”

16 **1.02 REFERENCE STANDARDS**

17 A. Institute of Electrical and Electronic Engineers (IEEE) Publications (most recent
18 published version):

- 19 1. IEEE 141 – Recommended Practice for Electric Power Distribution for Industrial Plants.
20 2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and
21 Commercial Power Systems.
22 3. IEEE 1584 – IEEE Guide for Performing Arc-Flash Hazard Calculations (most recent
23 publication).
24 4. NFPA 70 – National Electric Code.
25 5. NFPA 70E – Standard for Electrical Safety Requirements for Employee Workplaces.
26 6. OSHA 29-CFR – Occupational Safety and Health Standards: Electrical Part 1910
27 Subpart S.

1 **1.03 SUBMITTALS**

2 A. Procedures: As specified in Section 26 05 11, "Basic Electrical Methods and Materials."

3 B. Schedule:

4 1. Submit Short Circuit, Coordination, and Arc Flash Reports with equipment submittals.

5 2. Approved report required prior to energizing equipment.

6 3. Provide and install arc flash labels prior to commissioning.

7 C. Submit the name and the qualifications of the laboratory or consultant for review by the
8 Owner. Qualifications must include professional registration of proposed personnel as
9 electrical engineers.

10 D. Certified Short Circuit, Coordination, and Arc Flash Reports:

11 1. Preliminary Short Circuit, Coordination, and Arc Flash Report shall be submitted for
12 each construction phase:

13 a. Arc flash warning labels.

14 b. Protective devices trip settings.

15 c. An electronic copy of the Preliminary Short Circuit, Coordination, and Arc Flash
16 Report in PDF format.

17 d. Preliminary report shall use submitted information, existing equipment, and
18 estimated circuit lengths.

19 2. Final Power Study Report:

20 a. Arc flash warning labels.

21 b. Protective devices trip settings.

22 c. Two paper copies of the of the Short Circuit, Coordination, and Arc Flash Report.

23 d. An electronic copy of the Short Circuit, Coordination, and Arc Flash Report in
24 PDF format.

25 E. Electronic copy of model, settings, and report.

26 1. Electronic copy shall be a copy of the software format used to produce the
27 Short Circuit, Coordination, Arc Flash Report. The electronic copy shall include the
28 SKM model used for preparing the study.

1 **1.04 QUALITY ASSURANCE**

2 A. Qualifications:

3 1. Prepared by recognized independent testing laboratory or coordination analysis
4 consultant who is regularly engaged in power system studies.

5 B. Consultant Certification: Short Circuit, Coordination, and Arc Flash Reports to be stamped
6 and signed by an electrical engineer registered in the State of Washington.

7 **1.05 ENGINEERING SOFTWARE**

8 A. Software used to perform the following power system study shall be SKM Systems
9 Analysis, Inc.

10 1. Short Circuit Report.

11 2. Protective Device Coordination Report.

12 3. Arc Flash Report.

13 **PART 2 – PRODUCTS**

14 **2.01 SHORT CIRCUIT, COORDINATION, AND ARC FLASH REPORTS**

15 A. Scope of Effort:

16 1. Executive Summary:

17 a. The executive summary shall provide an overall evaluation of the three sections;
18 Short Circuit Report, Coordination Study, and Arc Flash Study.

19 b. The executive summary shall list any concerns or problems stated within the
20 individual reports and studies specified within this section.

21 2. The reports shall include all equipment shown on the one-line diagrams.

22 3. Short Circuit Report:

23 a. Prepare a report summarizing the short circuit and coordination study and
24 conclusions or recommendations that may affect the integrity of the electric power
25 distribution system.

26 b. As a minimum, include the following in the report:

27 1) Executive Summary.

28 2) Equipment manufacturer's information used to prepare the study.

29 3) Assumptions made during the study.

- 1 4) Short circuit calculations listing short circuit levels at each bus.
- 2 5) Evaluation of the electrical power system and the model numbers and settings
3 of the protective devices associated with the system.
- 4 6) Time-current curves, model numbers of the protective relays, and relay settings
5 associated with each breaker.
- 6 7) Comparison of short circuit duties of each bus to the interrupting capacity of
7 the equipment connected to that bus.
- 8 8) Tabulation of the circuit breaker, fuse, and other protective device ratings
9 versus calculated short circuit duties.
- 10 9) Recommendations for system improvements, where needed.
- 11 10) Short circuit/coordination studies software for performing this task shall be
12 PowerTools SKM software.
- 13 4. Short Circuit Study:
- 14 a. One-Line Diagram:
- 15 1) Location and function of each protective device in the system, such as relays,
16 direct-acting trips, fuses, etc.
- 17 2) Type designation, current rating, range or adjustment manufacturer's style, and
18 catalog transformers.
- 19 3) Power, voltage ratings, impedance, and primary and secondary connections of
20 all transformers.
- 21 4) Nameplate ratings of all motors and generators with their
22 subtransient reactances.
- 23 5) Transient reactances of generator and synchronous reactances of generator.
- 24 6) Sources of short circuit elements, such as utility, generator, and
25 induction motors.
- 26 7) All significant circuit elements, such as transformers, cables, breakers, fuses,
27 reactors, etc.
- 28 8) Standby as well as normal switching conditions.
- 29 b. Impedance Diagram:
- 30 1) Available MVA or impedance from the utility company, documented by letter
31 from the utility company and included with the submitted report.
- 32 2) Bus impedance.

- 1 3) Transformer and/or reactor impedances.
- 2 4) Cable impedances.
- 3 5) Equipment impedances.
- 4 6) System voltages.
- 5 7) Grounding scheme (resistance grounding, solid grounding, and no grounding).
- 6 c. Calculations:
- 7 1) Determine the paths and situations where short circuit currents are the
- 8 greatest. Assume bolted faults and calculate the three-phase and
- 9 line-to-ground short circuits of each case.
- 10 2) Calculate the maximum and minimum ground-fault currents.
- 11 5. Coordination Study:
- 12 a. Provide an evaluation of the electrical power system and the model numbers and
- 13 settings of the protective devices associated with the system.
- 14 b. As a minimum, include the following on five-cycle, log-log graph paper:
- 15 1) Time-current curve for each protective relay or fuse showing graphically that
- 16 the settings will allow protection and selectively within Industry standards.
- 17 Identify each curve and specify the tap and time dial setting.
- 18 2) Time-current curves for each device to be positioned for maximum selectivity
- 19 to minimize system disturbances during fault clearing. Where selectivity cannot
- 20 be achieved, notify the Owner and Engineer as to the cause.
- 21 3) Time-current curves and points for cable and equipment damage.
- 22 4) Circuit interrupting device operating and interrupting times.
- 23 5) Indicate maximum fault values on the graph.
- 24 6) Sketch of bus and breaker arrangement.
- 25 6. Arc Flash Report:
- 26 a. Prepare a report summarizing the arc flash study and conclusions or
- 27 recommendations that may affect the integrity of the electric power
- 28 distribution system.
- 29 b. A qualified engineer shall perform arc flash calculations to determine the incident
- 30 energy, arc flash boundary, and minimum PPE requirements for locations
- 31 throughout the power system. Arc flash warning labels are produced and attached
- 32 to the electrical equipment. These labels must indicate approach boundaries,

- 1 incident energy level, and minimum PPE that is required when servicing the
2 equipment within the arc flash boundary.
- 3 c. As a minimum, include the following in the report:
- 4 1) Equipment manufacturer's information used to prepare the study.
- 5 2) Assumptions made during the study.
- 6 3) Reduced copy of the one-line drawing.
- 7 4) Arc flash evaluations summary spreadsheet as specified within this section.
- 8 5) Bus detail sheets as specified within this section.
- 9 6) Arc flash analysis and calculations for all voltage levels of the electrical
10 power system.
- 11 7) Arc flash warning labels printed in color on adhesive-backed labels.
- 12 7. Arc Flash Study:
- 13 a. Perform an arc flash hazard study after the short circuit and protective device
14 coordination study has been completed.
- 15 b. For each major part of the electrical power system, determine the following:
- 16 1) Flash hazard protection boundary.
- 17 2) Limited approach boundary.
- 18 3) Restricted approach boundary.
- 19 4) Prohibited approach boundary.
- 20 5) Incident energy level.
- 21 6) PPE hazard/risk category.
- 22 7) Type of PPE required.
- 23 c. Produce arc flash warning labels listing Items b.1) through b.7), above. Also
24 include the bus name and voltage.
- 25 1) Provide labeling at each separately derived system indicating calculated
26 available fault current per NEC Article 110.24.
- 27 2) Arc flash labeling shall conform to the 2024 NFPA 70E and the
28 National Electrical Code (NEC).

- 1 d. Produce bus detail sheets that lists Items b.1) through b.7), above, and the
2 following additional items:
- 3 1) Bus name.
- 4 2) Upstream protective device name, type, and settings.
- 5 3) Bus line to line voltage.
- 6 e. Produce an arc flash evaluation summary sheet listing the following additional items:
- 7 1) Bus name.
- 8 2) Upstream protective device name, type, settings.
- 9 3) Bus line to line voltage.
- 10 4) Bus bolted fault.
- 11 5) Protective device bolted fault current.
- 12 6) Arcing fault current.
- 13 7) Protective device trip/delay time.
- 14 8) Breaker opening time.
- 15 9) Solidly grounded column.
- 16 10) Equipment type.
- 17 11) Gap.
- 18 12) Arc flash boundary.
- 19 13) Working distance.
- 20 14) Incident energy.
- 21 15) Required protective fire rated clothing type and class.
- 22 f. Analyze the short circuit, protective device coordination, and arc flash calculations
23 and highlight any equipment that is determined to be underrated or causes an
24 abnormally high incident energy calculation. Propose approaches to reduce the
25 energy levels.

1 **PART 3 – EXECUTION**

2 **3.01 GENERAL**

- 3 A. Perform the power study report in accordance with:
- 4 1. IEEE Standards 141, 242, and 1584.
- 5 2. NFPA 70E.
- 6 3. OSHA 29-CFR, Part 1910 Subpart S.
- 7 B. Perform the power studies using actual equipment data.
- 8 C. Provide on-site labor to collect field information and verify record information to prepare
- 9 the reports.

10 **3.02 PRELIMINARY AND FINAL POWER STUDY REPORTS**

- 11 A. Contractor shall provide preliminary power study report:
- 12 1. Preliminary power study report shall be provided prior to the energizing of equipment
- 13 and electrical power circuits.
- 14 2. Preliminary power study report shall provide trip settings to protect equipment and
- 15 personnel during equipment installation, startup, functional testing, and commissioning.
- 16 a. Trip settings shall be provided for the circuit breakers with adjustable trip settings.
- 17 B. Contractor shall provide final power study report:
- 18 1. Final power study report shall be provided after the completion of the project construction.
- 19 2. Final power study report shall include equipment in the model which matches the final
- 20 installed equipment and incorporate changes made during construction.
- 21 a. Final power study shall also include trip settings for the circuit breakers.
- 22 C. Contractor shall provide and apply arc flash warning labels for equipment.

23 **3.03 CONFIRM EXISTING CONDITIONS**

- 24 A. Owner will provide available record information as requested by the
- 25 Consultant/Contractor.
- 26 B. Contractor shall provide information to the Consultant preparing the power study.
- 27 C. Consultant preparing the report is responsible to field verify record information and collect
- 28 additional information for performing the study. Provide a minimum of one 8-hour day to
- 29 perform this field work.
- 30 D. Contractor shall make field adjustments to the protection devices as specified in the short
- 31 circuit, coordination, and arc flash study.

32 **END OF SECTION**

1 **1.03 QUALITY ASSURANCE**

2 A. Referenced Standards: This section incorporates by reference the latest revisions of the
3 following documents. In case of conflict between the requirements of this section and the
4 listed documents, the requirements of the Contract Specifications shall prevail.

5 1. National Electrical Manufacturers Association (NEMA).

6 2. International Electrical Testing Association Inc. Acceptance Testing
7 Specifications (NETA).

8 3. NFPA 70 – National Electrical Code (NEC).

9 **1.04 DAMAGED PRODUCTS**

10 A. See Section 26 05 11 in the event that any equipment or material is damaged.

11 **PART 2 – PRODUCTS (NOT USED)**

12 **PART 3 – EXECUTION**

13 **3.01 CONSTRUCTION INSPECTIONS**

14 A. Commissioning of electrical systems will require inspection of individual elements of the
15 electrical systems construction throughout the construction period. The Contractor shall
16 coordinate with the Owner to schedule electrical systems inspections as required to
17 support the commissioning process.

18 **3.02 TESTING PROCEDURES**

19 A. General:

20 1. Electrical Testing requirement for new equipment:

21 a. Panelboards:

22 1) Exercise each breaker by moving handle from the CLOSED position to the
23 OPEN position and then back to the CLOSED position.

24 a) Verify handle selection to each position operates properly and is
25 smooth operation.

26 2) Perform the tug test on each wire/conductor which is terminated within
27 the panelboard.

28 a) Verify each termination is properly torqued to ensure conductor is
29 properly terminated.

30 3) Verify NEMA cover (door) can be fully closed and secured in the
31 closed position.

- 1 4) Inspect panelboard for physical and mechanical condition.
- 2 5) Inspect anchorage, alignment, and grounding.
- 3 6) Prepare test report describing testing performed and results. Submit
- 4 test report.
- 5 7) Submit certificate that equipment is fully operational and performing properly.
- 6 a) Certificate shall include equipment name, manufacturer, equipment model
- 7 number, equipment serial number.
- 8 b) Sign, print name, and date certificate.
- 9 b. Pump Control Panel:
- 10 1) Integrator and Panel Shop shall functionally test pump control panel and all
- 11 devices within the pump control panel.
- 12 a) Test both manual and automatic operations of the control of the pumps.
- 13 b) Testing shall include pumping operations of Wet Well with varying liquid
- 14 level heights from low to high-high.
- 15 c) Prepare test report describing testing performed and results. Submit
- 16 test report.
- 17 d) Submit certificate that equipment is fully operational and
- 18 performing properly.
- 19 e) Certificate shall include equipment name, manufacturer, equipment model
- 20 number, equipment serial number.
- 21 f) Sign, print name, and date certificate.

22 B. Division of Responsibility:

- 23 1. Contractor responsibilities for providing information required by the testing agency:
- 24 a. The Contractor shall provide an approved copy of the short-circuit analysis,
- 25 coordination study and protective device setting report that is specified in
- 26 Section 26 05 73.
- 27 b. The Contractor shall provide the required equipment instruction manuals
- 28 requested by the testing agency.
- 29 c. The Contractor shall provide a copy of the list of equipment that will be tested under
- 30 this Contract.
- 31 d. The Contractor shall be responsible for providing suitable power for testing as
- 32 required by the testing agency.

- 1 e. The Contractor shall be responsible for coordinating the scheduling of testing with
2 the testing agency.
- 3 f. The Contractor shall be responsible for providing the site-specific hazard and
4 safety training for the testing agency.
- 5 g. The Contractor shall notify the Owner 14 days ahead of planned testing.
- 6 C. Testing agency responsibilities include testing procedures for equipment, testing forms to
7 record testing results, signature, printed name, and date plus Contractor witnessing
8 signature, printed name and date. Safety, Test Equipment Calibration and Reports:
- 9 1. Conform to the national, state, and Tulalip Tribes safety requirements.
- 10 2. Test equipment shall be calibrated and the calibration information recorded on the
11 submitted test reports.
- 12 3. Test reports shall include all the testing requirements. Equipment identification shall
13 include the equipment name and number per project Drawings.
- 14 D. Communications and Controls: Testing of Modbus, Ethernet, DeviceNet, ControlNet, or
15 Foundation Fieldbus circuits and communications is specified in CSI Division 40.
- 16 E. Test Reports:
- 17 1. Provide and submit test reports.
- 18 2. Use the project full equipment name and equipment number for
19 equipment identification.
- 20 3. Provide a copy of the final test report in both electronic Microsoft Word format and
21 PDF. Images in the report may be in JPEG or Adobe Acrobat PDF format.
- 22 F. Testing organization shall perform acceptance tests and inspections. Test methods,
23 procedures, and test values shall be performed and evaluated with the manufacturer's
24 recommendations.
- 25 1. Equipment shall be placed in service only after completion of required tests and
26 evaluation of the test results have been completed.
- 27 2. Contractor shall supply to the testing organization complete sets of shop drawings,
28 settings of adjustable devices, and other information necessary for an accurate test
29 and inspection of the system prior to the performance of any final testing.
- 30 3. Owner shall be notified at least 14 days in advance of when tests will be conducted by
31 the testing organization.
- 32 G. Function testing of the process controls related to equipment is specified in CSI
33 Division 40 of these Specifications. Only those devices that are related to the protection
34 of electrical equipment such as interlocks, alarms, fail safe devices will be tested.

- 1 H. Electrical functional testing may be performed by qualified electricians (not required to be
2 done by an independent test agency) or by the independent testing agency under
3 this section.
- 4 I. Perform the functional testing per equipment manufacturer's function tests requirements
5 prior to energizing of the equipment.
- 6 J. Application-specific electrical functional performance testing of equipment is described in
7 the individual equipment specifications.
- 8 K. System Functional Performance Testing:
- 9 1. The Functional Performance Testing Procedures approved by the Engineer will be
10 used to document the inspection and testing of the equipment and systems. Provide
11 all necessary manpower and have the appropriate subcontractor and/or
12 manufacturer's representative present during the testing and demonstrate, to the
13 Engineer's satisfaction, the full operation of all electrical and lighting systems.
14 Coordinate the schedule of the testing so that the Engineer and Owner can be present.
- 15 2. Prior to starting the final testing of the systems, ensure that all equipment and systems
16 were initially started up and initialized as prescribed by the manufacturer's instructions
17 or by the manufacturer's representative and that the Contractor has performed a
18 complete inspection and test of all electrical and lighting equipment and systems.

19 **END OF SECTION**
20

- 1 H. Electrical functional testing may be performed by qualified electricians (not required to be
2 done by an independent test agency) or by the independent testing agency under
3 this section.
- 4 I. Perform the functional testing per equipment manufacturer's function tests requirements
5 prior to energizing of the equipment.
- 6 J. Application-specific electrical functional performance testing of equipment is described in
7 the individual equipment specifications.
- 8 K. System Functional Performance Testing:
- 9 1. The Functional Performance Testing Procedures approved by the Engineer will be
10 used to document the inspection and testing of the equipment and systems. Provide
11 all necessary manpower and have the appropriate subcontractor and/or
12 manufacturer's representative present during the testing and demonstrate, to the
13 Engineer's satisfaction, the full operation of all electrical and lighting systems.
14 Coordinate the schedule of the testing so that the Engineer and Owner can be present.
- 15 2. Prior to starting the final testing of the systems, ensure that all equipment and systems
16 were initially started up and initialized as prescribed by the manufacturer's instructions
17 or by the manufacturer's representative and that the Contractor has performed a
18 complete inspection and test of all electrical and lighting equipment and systems.

19 **END OF SECTION**
20

1 **SECTION 26 24 16**

2 **PANELBOARDS**

3 **PART 1 – GENERAL**

4 **1.01 SUMMARY**

- 5 A. This section specifies low-voltage electrical panelboards with circuit breakers and fuses
6 as specified in this section and on the Drawings.

7 **1.02 REFERENCE STANDARDS**

- 8 A. Comply with the following requirements:

- 9 1. Federal Specifications W-P-115C.
10 2. NEMA PB1.
11 3. NFPA 70 National Electrical Code (NEC).
12 4. UL 50 – Cabinets and boxes.
13 5. UL 67 – Panelboards.
14 6. UL 98 – Fusible Switches.
15 7. NETA ATS – International Electrical Testing Association Acceptance
16 Testing Specifications.
17 8. Local codes and ordinances.

18 **1.03 SUBMITTALS**

- 19 A. Procedures: Refer to Section 26 05 11, “Basic Electrical Methods and Materials.”

- 20 B. Shop Drawings:

- 21 1. Submit product information/data shop drawings for materials.
22 2. Provide the following information for each panelboard:
23 a. Manufacturer cut sheets (product data sheet).
24 b. Panelboard type.
25 c. Main bus and terminal connection sizes.
26 d. Location of line connections.
27 e. Cabinet dimensions.

- 1 f. Gutter space.
- 2 g. Gauge of boxes and fronts.
- 3 h. Finish data.
- 4 i. Voltage and amp ratings.
- 5 j. Panel schedule including breaker types, trip ratings, and interrupting ratings.
- 6 k. Cable terminal sizes.
- 7 l. Surge Protection Device (SPD) product information.
- 8 m. Seismic Certification and equipment anchoring details.
- 9 n. Factory Test Plan.
- 10 o. Field Test Plan.
- 11 p. Certified production test reports.
- 12 q. Field Test Reports: Indicate test results compared with specified performance
- 13 requirements and provide justification and resolution of differences if values do
- 14 not agree.
- 15 3. Submit operation and maintenance manuals as specified in Section 26 05 11, "Basic
- 16 Electrical Methods and Materials."

17 **1.04 SEISMIC ANCHORAGE AND STRUCTURAL DATA**

- 18 A. Mechanical instrumentation and control, electrical, nonstructural systems, components,
- 19 and elements permanently attached to the structure shall be anchored and braced to resist
- 20 seismic forces. Contractor shall design the structural components, seismic attachment,
- 21 braces, and anchors to the structure for all parts or elements of the mechanical and
- 22 electrical systems in accordance with Section 13 05 41.

23 **1.05 WARRANTY**

- 24 A. In addition to the warranty specified in CSI Division 1, the manufacturer's warranty to
- 25 Owner shall in no event be for a period of less than 1 year starting from when the
- 26 equipment and installation are substantially complete.
- 27 B. Warranty shall include repair parts, labor, and travel expenses.

1 **1.06 DELIVERY, STORAGE, AND HANDLING**

2 A. Contractor shall ensure electrical equipment received is stored in a dry, secured, safe
3 location, protected for water, rain, dirt, construction debris, and physical damage. Storage
4 and handling shall be per the manufacturer's requirements.

5 1. Contractor is responsible for electrical equipment until the equipment has been
6 commissioned and successfully demonstrated to the Owner.

7 **PART 2 – PRODUCTS**

8 **2.01 PANELBOARDS**

9 A. General:

10 1. Panelboards shall be the automatic-circuit-breaker type, as indicated on the Drawings.
11 The number and arrangement of circuits, trip ratings, spares, and blank spaces for
12 future circuit breakers shall be as shown on the Drawings.

13 2. Each panelboard shall have a nameplate as specified in Section 26 05 53 and giving
14 the panel identification as shown on the Drawings.

15 a. In addition, each panelboard shall have a manufacturer's nameplate showing the
16 voltage, bus rating, number of phases and wires, frequency, and manufactured
17 month/year date.

18 3. Where specified, panelboards enclosures shall be as follows:

19 a. NEMA 3R for outdoor, wet, and damp locations.

20 4. Panelboards and enclosures shall conform to NEMA PB1 and 250, UL 50, and
21 requirements of relevant codes. Panelboards used as service equipment shall conform
22 to UL 869A, and panelboard shall be UL labeled.

23 5. Circuit breakers shall be bolt-on type, heavy duty, quick make, quick break, single- and
24 multi-pole circuit breakers of types specified herein; shall be provided for each circuit
25 with toggle handles that indicate when unit has tripped.

26 B. Construction:

27 1. Interiors shall be completely factory assembled. They shall be designed such that
28 switching and protective devices can be replaced without disturbing adjacent units and
29 without removing the main bus connectors.

30 2. Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit
31 breaker handles. Doors shall have a means to lock hinged door preferable padlock
32 hasp. If padlock hasp is not available, then keyed cylinder lock shall be provided.
33 Hinged door shall utilize three-point latching. Equip locking tab with provision for a
34 screw such that removal of trim requires a tool, at the Owner's option. Installation shall
35 be tamper-resistant.

1 3. Distribution panelboard trims shall cover all live parts. Switching device handles shall
2 be accessible.

3 4. Surface trims shall be same height and width as box.

4 5. A directory card with a clear plastic cover shall be supplied and mounted on the inside
5 of each door.

6 C. Bus:

7 1. Main bus bars shall be tin-plated copper sized in accordance with UL standards to limit
8 temperature rise on any current carrying part to a maximum of 65°C above an ambient
9 of 40°C maximum.

10 2. A system ground bus shall be included in all panels. Ground bus shall be copper.

11 3. Full-size (100% rated) insulated stand-off neutral bus shall be included for panelboards
12 shown with neutral. Bus bar taps for panels with single-pole branches shall be
13 arranged for sequence phasing of the branch circuit devices. Neutral busing shall have
14 a suitable lug for each outgoing feeder requiring a neutral connection.
15 Two-Hundred-percent-rated neutrals shall be supplied for panels designated on
16 drawings with oversized neutral conductors. Neutral bus bar shall be copper.

17 D. Lighting Panelboards – Circuit Breaker Type:

18 1. Lighting panelboards shall be rated 240 Y/120 V, four-wire, with bus ratings as shown
19 on the Drawings. Main circuit breaker and branch circuit breakers shall have minimum
20 interrupting ratings of 22,000 rms symmetrical amperes at 240 V unless otherwise
21 specified on Drawings. Series rated interruption rating shall not be used.

22 2. Provide permanently installed lockout means for each individual circuit breaker handle
23 for lockout/tagout procedures.

24 3. Current ratings, configuration of poles, and number of circuits shall be indicated on
25 Drawings.

26 E. Enclosure:

27 1. Enclosures shall be at least 20 inches wide made from galvanized steel. Provide
28 minimum gutter space in accordance with the National Electrical Code. Where feeder
29 cables supplying the mains of a panel are carried through its box to supply other
30 electrical equipment, the box shall be sized to include the additional required wiring
31 space. At least four interior mounting studs with adjustable nuts shall be provided.

32 F. Surge Protection Device:

33 1. Surge protection devices (SPD) shall be provided for external mounting, outside of the
34 panelboard. The Panelboard shall provide a 3 pole circuit breaker for the external
35 mounted surge protection device as shown on the panelboard schedule.

36 a. Panelboards shall provide branch fuses or circuit breaker to connect the bus to
37 SPD.

- 1 1) Provide protection device sized per the manufacturer's recommendation.
- 2 2. SPDs shall have indicator LED to indicate protection status.
- 3 3. SPDs shall have surge counters.
- 4 4. SPDs shall be configured to support the panelboard voltage rating and
- 5 wiring configuration.
- 6 G. Acceptable Manufacturers:
- 7 1. Eaton.
- 8 2. Schneider Electric.
- 9 3. Or approved equal.
- 10 4. The design was based upon Eaton Panelboards and the space as shown on the
- 11 Drawings. Other manufacturer's panelboards shall meet the requirements specified
- 12 within this section and shown on the Drawings.

13 **PART 3 – EXECUTION**

14 **3.01 FACTORY TESTING**

- 15 A. The standard factory tests shall be performed on the equipment provided under this section.
- 16 All tests shall be in accordance with the latest version of ANSI, NEMA, and UL standards.
- 17 B. The manufacturer shall submit three certified copies of factory test reports.

18 **3.02 MANUFACTURER'S CERTIFICATION**

- 19 A. A certified test report of all standard production tests shall be submitted.

20 **3.03 INSTALLATION**

- 21 A. The Contractor shall install all equipment per the manufacturer's instructions, as indicated
- 22 on the Drawings and in accordance with the NEC.
- 23 B. Seismic anchorage and bracing as specified in Section 13 05 41.
- 24 C. A directory card shall be typed completed, identifying every circuit. Handwritten
- 25 not acceptable.
- 26 D. The current transformers for the Power Monitor shall be in the panelboard gutters. Phase
- 27 loss relay shall monitor the three power in the panelboard, see panelboard schedule. Note
- 28 the Power monitor is in the adjacent power quality enclosure (PQ-105A).
- 29 E. The surge protection device for the panelboard shall be in the adjacent power quality
- 30 enclosure (PQ-105A).

1 **3.04 MOUNTING HEIGHTS**

2 A. Lighting and distribution panelboards shall be mounted with the top of the box 6 feet
3 6 inches above the floor. Panelboards shall be plumb within 1/8 inch. The highest breaker
4 operating handle shall not be higher than 72 inches above the floor.

5 **3.05 FIELD ADJUSTMENTS**

6 A. The Contractor shall perform field adjustments of the protective devices as required to
7 place the equipment in final operating condition. The settings shall be in accordance with
8 the approved short-circuit, coordination, and arc flash study per Section 26 05 73.

9 B. Necessary field settings of devices, adjustments and minor modifications to equipment to
10 accomplish conformance with an approved short circuit and protective device coordination
11 study shall be carried out by the Contractor at no additional cost to the Owner.

12 **3.06 FIELD TESTS**

13 A. Contractor shall perform manufacturer-submitted Field Test Plan.

14 B. Contractor shall perform Visual and Mechanical Inspection as specified in
15 NETA ATS – Section 7.5 for switches and Section 7.6 for molded case circuit breakers.

16 C. Contractor shall include the following inspections and related work:

17 1. Inspect for defects and physical damage, labeling, and nameplate compliance with
18 requirements of up-to-date drawings and panelboard schedules.

19 2. Exercise and perform operational tests of all mechanical components and other
20 operable devices in accordance with manufacturer's instruction manual.

21 3. Check panelboard mounting, area clearances, and alignment and fit of components.

22 4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer
23 to manufacturer's instructions for proper torque values.

24 D. Insulation-Resistance Tests: Perform insulation-resistance tests on circuits to be
25 energized with a line-to-neutral voltage of 120 V or more. Make these tests after
26 equipment has been connected, except that equipment that may be damaged by the test
27 voltage shall not be connected. Test the insulation with a 500 VDC insulation-resistance
28 tester with a scale reading 100 megohms. The insulation resistance shall be 20 megohms
29 or more. Submit results for review.

30 E. Continuity: Panelboard circuits shall be tested for continuity prior to energizing. Continuity
31 tests shall be conducted using a dc device with a bell or buzzer.

32 **END OF SECTION**

- 1 P. UL 943A, 943B: Leakage Current Protection.
- 2 Q. UL 98: Enclosed and Dead-Front Switches.
- 3 R. UL 1682: Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type.
- 4 S. UL 1686: UL Standard for Safety Pin and Sleeve Configurations.

5 **1.03 SUBMITTALS**

- 6 A. Procedures: Refer to Section 26 05 11, "Basic Electrical Methods and Materials."
- 7 B. Shop Drawings: Provide shop drawings showing the locations and bill of material for the
- 8 equipment specified in this section.
- 9 C. Submit the manufacturer's product information and manufacturer's detailed specifications
- 10 for the equipment specified in this section.
- 11 D. Submit operation and maintenance manuals as specified in Section 26 05 11,
- 12 "Basic Electrical Methods and Materials."

13 **1.04 QUALITY ASSURANCE**

- 14 A. Source Quality Control:
 - 15 1. Products shall be listed and labeled by an approved Nationally Recognized Testing
 - 16 Lab (NRTL) such as Underwriter's Laboratories, Inc. (UL), Energy Technology List
 - 17 (ETL), or Canadian Standards Association.

18 **1.05 WARRANTY**

- 19 A. The manufacturer's warranty to Owner shall in no event be for a period of less than 1 year
- 20 starting from when the equipment and installation are substantially complete.
- 21 B. Warranty shall include repair parts, labor, and travel expenses.

22 **PART 2 – PRODUCTS**

23 **2.01 GENERAL**

- 24 A. Individual device types shall be provided from a single manufacturer.
- 25 B. Acceptable Manufacturers:
 - 26 1. Hubbell.
 - 27 2. Leviton.
 - 28 3. Pass & Seymour.
 - 29 4. Or approved equal.

1 **2.02 RECEPTACLES**

2 A. General: Receptacles shall be specification grade, heavy-duty, high-abuse, grounding
3 type conforming to NEMA configurations, NEMA WD1, and UL 498 Standards.

4 B. Single and Duplex Receptacles:

5 1. Receptacles shall be of back and side wire design utilizing screw-type terminals.
6 Receptacles shall be rated 20 A, two-pole, three-wire, 120 V, NEMA 5-20
7 configuration, self-grounding. Power contacts shall be a T-type design and shall be
8 brass. Ground contacts shall be brass. Color shall be as follows:

9 a. Ivory in industrial areas:

10 1) Ivory for receptacles supplied by normal power source.

11 b. Ivory or white in office and laboratory areas.

12 c. Blue for receptacles supplied by UPS power source.

13 d. Red for receptacles supplied by generator power source.

14 2. Devices shall have a nylon or polycarbonate composition face with a nylon or
15 melamine body. Units shall comply with Federal Specification W-C-596E and meet
16 UL 498 test requirements.

17 C. Special Purpose Receptacles: Receptacles shall be of the amperage, voltage, and NEMA
18 configuration indicated on the Drawings. Compliance to standards and tests shall be as
19 listed in Item B above.

20 D. GFI Receptacles:

21 1. Device shall be rated 20 A, two-pole, three-wire, 120 V, conforming to NEMA
22 WD1.10 configuration. Face shall be nylon or polycarbonate composition meeting
23 UL 498 test standards. Unit shall have test and reset push buttons and LED indicator.

24 2. GFCI component shall meet UL 943 Class A standards with a tripping time of
25 1/40 second at 5 mA current unbalance. Operating range shall extend from 31°F to
26 158°F. Unit shall have transient voltage protection and shall be ceramic encapsulated
27 for protection against moisture.

28 E. Corrosion-Resistant Receptacles: Units shall comply with standards listed in Item B above
29 but shall also have tin-nickel-plated brass connecting equipment and stainless-steel
30 hardware. Receptacle face color shall be yellow to identify the device as having these
31 special qualities.

32 **2.03 SWITCHES**

33 A. Line-Voltage Types: Switches shall be rated 20 A at 120 V, ac only. Units shall be
34 flush-mounted, self-grounding, quiet-operating toggle devices. The handle color shall be
35 ivory in industrial areas and white or ivory in office and laboratory areas. Units shall

1 conform to Federal Specifications W-S-896 D and E, UL 20-11 and UL 20-2, and
2 NEMA WD1 Standards.

3 B. 120 V instrumentation and controls snap type switches:

4 1. Provide locking switch position covers so the switch can be locked in either the
5 ON position or OFF position.

6 a. Cantix Part Number 513330.

7 b. Eaton Crouse-Hinds Catalog Number DS185.

8 c. Hubbell Catalog Number HBL1372D.

9 d. Or approved equal.

10 C. Commercial Rotary Auto-OFF Timer Switch:

11 1. Time Cycle: 12 Hour.

12 2. Switch: SPST.

13 3. Hold: No.

14 4. Color: Brushed Metal Finish.

15 5. Rating:

16 a. Resistive: 20 A, 125 VAC.

17 b. Motor: 1 hp, 120 V, 60 Hz.

18 6. Sized to fit inside a single gang electrical box.

19 7. Manufacturer: Intermatic FF Series Auto-Off Timer or equal.

20 **2.04 PLATES AND COVERS**

21 A. General: Plates shall be of the style and color to match the wiring devices, and of the
22 required number of gangs. Plates shall conform to NEMA WD1, UL 514, and ANSI C73.
23 Plates on unfinished walls and on fittings shall be of zinc-plated steel or cast metal having
24 rounded corners and beveled edges.

25 B. Nonmetallic: Plates shall be smooth finish with contoured edges and shall be nylon
26 or fiberglass.

27 C. Stainless Steel: Plates shall be 0.035 inches thick with beveled edges and shall be
28 manufactured from No. 302 alloy having a brushed or satin finish.

29 D. Galvanized: Plates shall be galvanized sheet steel raised 1/2 inch, with rounded corners.

- 1 E. Cast Metal: Plates shall be cast or malleable iron covers with gaskets so as to be moisture
2 resistant or weatherproof.
- 3 F. Damp or Wet and Corrosive Locations: Plates shall have weather protective doors.
4 Material of manufacture shall be die-cast aluminum for metallic plates or nylon for
5 nonmetallic plates.
- 6 G. Outdoor Locations:
- 7 1. Receptacles: While-in-use style weatherproof cover, cast metal, while-in-use cover,
8 padlockable in the closed position.
- 9 2. Switches: Locking weatherproof, cast metal, padlockable toggle switch cover.
- 10 3. Commercial Auto-OFF Timer Switch:
- 11 a. Weatherproof nonmetallic covers, extra-duty nonmetallic weatherproof while-in-
12 use cover.
- 13 1) Clear cover.
- 14 b. Compliant with NEC requirements for wet locations.
- 15 c. Stainless steel hinge pin for rugged cover attachment.
- 16 d. Locking cover for compliance with OSHA lockout/tagout (LOTO) requirements.
- 17 e. Adapter plate and premounted gaskets.
- 18 f. Single gang for support commercial Auto-OFF Timer switch weatherproof metallic
19 electrical box.

20 **PART 3 – EXECUTION**

21 **3.01 INSTALLATION OF WIRING DEVICES**

- 22 A. Damp or Wet Exterior Locations: Install only wiring devices approved for outdoor service
23 in these locations.
- 24 B. Receptacles:
- 25 1. Receptacles shall be grounded by a grounding conductor, not by a yoke or screw contact.
- 26 2. Receptacles shall be installed with connections pigtailed (spliced) to the branch circuit
27 wiring so that removal of the receptacle will not lose neutral continuity and branch
28 circuit power will not be lost to other receptacles on the same circuit.
- 29 C. Switch-rated Plugs and Receptacles:
- 30 1. Coordinate with Owner on the installation of the new plug/receptacles.
- 31 2. Replace the existing plugs on the existing equipment with the new plugs.

1 **SECTION 26 28 00**

2 **LOW-VOLTAGE CIRCUIT PROTECTIVE DEVICES**

3 **PART 1 – GENERAL**

4 **1.01 SUMMARY**

- 5 A. This section specifies overcurrent protective devices as shown on the Drawings, as
6 specified herein, and as needed for a complete and proper installation.

7 **1.02 SUBMITTALS**

- 8 A. Procedures: Refer to Section 26 05 11, "Basic Electrical Methods and Materials."
9 B. Submit shop drawings, including electrical ratings, physical size, interrupt ratings,
10 trip curves, I²t curves, and manufacturer's detailed specifications.
11 C. Submit operation and maintenance manuals as specified in Section 26 05 11, "Basic
12 Electrical Methods and Materials."

13 **1.03 QUALITY ASSURANCE**

- 14 A. Comply with the following requirements:
15 1. NFPA 70 National Electrical Code (NEC).
16 2. Local codes and ordinances.
17 3. Provide overcurrent protective devices by same manufacturer for each type of device.

18 **1.04 DELIVERY, STORAGE, AND HANDLING**

- 19 A. Contractor shall ensure electrical equipment received is stored in a dry, secured, safe
20 location, protected for water, rain, dirt, construction debris, and physical damage. Storage
21 and handling shall be per the manufacturer's requirements.
22 B. Contractor is responsible for electrical equipment until the equipment has been
23 commissioned and successfully demonstrated to the Owner.

24 **1.05 SPARE PARTS**

- 25 A. Provide the following spare parts to the Owner that match items specified:
26 1. In Three-Phase Circuits: Three fuses of each type and rating for the Service Entrance
27 Disconnect Switch as well as the finger safe fuse holders in the Power Quality Panel.
28 2. In Single-Phase Circuits: Two fuses of each type and rating for any fuse located in the
29 Pump Control Panel.

1 **1.06 WARRANTY**

2 A. Warranty shall include repair parts, labor, and travel expenses.

3 B. In addition to the Warranty specified in CSI Division 1, the manufacturer's warranty to
4 Owner shall in no event be for a period of less than 1 year starting from when the
5 equipment and installation are substantially complete.

6 **PART 2 – PRODUCTS**

7 **2.01 FUSES**

8 A. General purpose fuses for protection of motors, transformers, feeders, and main service:

9 1. Use UL Class RK5.

10 a. Single end rejection or to fit mountings specified.

11 b. 0 to 600 A rating.

12 1) As specified on the Drawings.

13 c. 200,000 A interrupting capacity.

14 d. Dual element, time delay.

15 e. Use Ferraz Shawmut, or approved equal: 250 V rating.

16 B. General purpose fuses for protection of motor control circuits, lighting ballasts, control
17 transformers, and street lighting fixtures:

18 1. Use UL Class CC, fast acting, single element fuses.

19 2. Rated for 0 A to 30 A.

20 a. As specified in specification sections or on Drawings.

21 3. Provide 200,000 A interrupting capacity.

22 4. Use Bussman Limitron KTK-R, or approved equal: 600 V rating.

23 **2.02 MOLDED CASE CIRCUIT BREAKERS**

24 A. General:

25 1. Comply with UL 489 requirements.

26 2. Provide thermal and magnetic protection.

- 1 B. Provide permanent trip power panel circuit breakers as follows:
- 2 1. Adjustable electronic trip.
- 3 2. Ground fault trip functions shall be applied as required by the NEC.
- 4 3. Bolt-on type.
- 5 4. 240 V or less short circuit rating (integrated equipment rating):
- 6 a. Main: 22,000 RMS symmetrical amps minimum.
- 7 b. Feeder: 22,000 RMS symmetrical amps minimum.
- 8 C. DIN rail Mounted Circuit Breakers.
- 9 1. Use UL 1077 recognized DIN rail mounted circuit breakers up to 63 A current rating.
- 10 a. Breakers are installed on standard DIN rail.
- 11 2. Standard ratings of 10 kAIC up to 277/480 V.
- 12 3. Available in single pole, two pole, three pole configurations.
- 13 4. Available in varying current ratings for response time of instantaneous trip current
- 14 ratings.
- 15 5. Suitable for supplementary protection.
- 16 6. Thermal-magnetic overcurrent protection.
- 17 7. Trip-free design – breaker can not be defeated by holding the handle in the ON
- 18 position.
- 19 8. Captive screws cannot be lost.
- 20 9. Contact position indicator (red/green).
- 21 10. Breaker information printed on the front of the device for quick identification.

22 **PART 3 – EXECUTION**

23 **3.01 INSTALLATION**

- 24 A. Install overcurrent protective devices in accordance with manufacturer's recommendations.
- 25 B. Ground/bond protection device enclosure to comply with NEC.

1 **3.02 ADJUSTMENT**

- 2 A. Set and record adjustable settings on circuit breakers per coordination study report to
3 provide selective coordination and proper operation.

4 **END OF SECTION**

1 **SECTION 26 33 53**

2 **UNINTERRUPTIBLE POWER SUPPLIES (UPS)**

3 **PART 1 – GENERAL**

4 **1.01 SUMMARY**

5 A. This section specifies uninterruptible power supplies (UPS) for maintaining continuity of
6 power supplies to vital control equipment during power system brief outages.

7 **1.02 QUALITY ASSURANCE**

8 A. Referenced Standards: This section incorporates by reference the latest revision of the
9 following document. These references are a part of this section as specified and modified.
10 In case of conflict between the requirements of this section and that of the listed document,
11 the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ANSI/NEMA ICS 6	Enclosures for Industrial Controls and Systems.
UL 508	Industrial Control Equipment.
ANSI C62.41 (IEEE 587)	Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits FCC Part 15 Class A.
NEMA PE-1	Uninterruptible Power Systems.
NFPA 70	(National Fire Protection Association) – National Electrical Code.
NFPA 75	Electronic Computer/Data Processing Equipment.
UL 1778	Uninterruptible Power Supply Equipment.
IEEE 1184	Guide for Selection and Sizing of Batteries for Uninterruptible Power Systems.
NEMA 250	Enclosures for Electrical Equipment.
NETA ATS	International Electrical Testing Association Electrical Testing Specifications.

12 B. Control Panel assembly shall conform to UL 508.

13 C. Source Limitations: Obtain the UPS and associated components specified in this section
14 from a single manufacturer with responsibility for the entire UPS installation.

15 D. Listing and Labeling: Provide electrical components, devices, and accessories that are
16 Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to
17 the Authority Having Jurisdiction, and marked for intended use for the location and
18 environment in which they are installed:

19 1. UPS Units: Listed and labeled under UL 1778.

1 **1.03 SUBMITTALS**

2 A. Procedures: Section 26 05 11, "Basic Electrical Methods and Materials."

3 B. Catalog cut sheets.

4 C. Shop drawings including but not limited to:

5 1. Layout drawings of the UPS control panels indicating the front door and rear panel
6 equipment arrangement, dimensions, and required working clearances. A list of
7 materials and components shall accompany the layout drawings.

8 2. Elementary and internal connection diagrams.

9 3. Layout drawings of the associated power supplies showing dimensions.

10 4. List of recommended standby components.

11 D. UPS sizing calculations and battery run time graphics (Runtime (Minutes) vs. Load
12 (Watts)).

13 E. Operation and Maintenance manuals.

14 F. Factory Test Reports: Comply with specified requirements.

15 G. Field Test Reports: Indicate test results compared with specified performance
16 requirements, and provide justification and resolution of differences if values do not agree.
17 Include manufacturer's written certification verifying proper installation.

18 H. Maintenance Data: For UPS units to include in maintenance manuals. Include the following:

19 1. Lists of spare parts and replacement components recommended being stored at
20 project site for ready access.

21 2. Detailed operating instructions covering operation under both normal and abnormal
22 conditions.

23 I. Warranties: Special warranties specified in this section.

24 **1.04 SPARE PARTS**

25 A. None.

26 **1.05 WARRANTY**

27 A. The manufacturer's warranty to the Owner shall in no event be for a period of less than
28 2 years starting from when the equipment and installation are substantially complete.

29 B. Warranty shall include repair parts, labor, shipping, and travel expenses.

1 **1.06 SEISMIC ANCHORAGE AND STRUCTURAL DATA**

2 A. Refer to Section 13 05 41 for seismic requirements.

3 **1.07 DELIVERY, STORAGE AND HANDLING**

4 A. Equipment shall be handled and stored in accordance with manufacturer's instructions.
5 One copy of these instructions shall be included with the equipment at time of shipment.

6 B. Contractor shall store UPS in dry, temperature-controlled location and provide protection
7 from dust, debris, and moisture while electrical equipment is stored before installation.

8 **PART 2 – PRODUCTS**

9 **2.01 ACCEPTABLE MANUFACTURER**

10 A. Phoenix Contact, APC, Eaton or Approved Equal: 24 VDC input and output. Contractor to
11 verify and coordinate voltage with control panel power supply and what is required on the
12 Drawings for power distribution and compatibility.

13 **2.02 GENERAL**

14 A. Provide a UPS at locations shown on the Drawings.

15 B. UPSs shall be sized to maintain operation of communication equipment, instrumentation
16 equipment, and control equipment located at each of the respective locations shown on
17 the Drawings and provided under this Contract, plus an allowance of 20% for future power
18 growth.

19 C. UPS will be sized for the loads being serviced. Contractor shall provide calculations of
20 designed loads and any change orders that may affect the loading of the UPS.

21 D. Battery sizing shall be calculated based on total load as defined in Paragraph 2.02, B. for
22 a period of not less than 1 hour without UPS input power and shall have sufficient battery
23 charging capacity to restore the batteries to 90% charge within 5 hours after return of UPS
24 input power.

25 E. Functional Description:

26 1. Normal: In normal operation, incoming power shall also be derived from the 24 VDC
27 power supply for the battery charger. The battery shall be charged once the unit is
28 connected to supply power, regardless of whether the UPS is ON or OFF. In the event
29 of a utility outage or severe abnormality (sag or swell), the UPS shall support the
30 connected load from battery power until the battery is discharged or the utility returns,
31 whichever occurs first.

- 1 2. Battery: Upon failure of utility/main AC power, the critical DC load shall be supplied by
2 the battery. There shall be no interruption in power to the critical load upon failure or
3 restoration of the utility/mains AC source:
 - 4 a. Batteries shall be hot-swappable.
 - 5 3. Recharge: Upon restoration of utility/main AC power, after a utility/main AC power
6 outage, the input shall automatically restart and assume supplying power to the battery
7 charger to recharge the battery.
 - 8 4. Internal Bypass: The integral bypass shall perform an automatic transfer of the critical
9 DC load from the battery to the bypass source, in the event of an overload, internal
10 over temperature, or overvoltage.
 - 11 5. Automatic Restart: Upon restoration of utility/main AC power, after a utility/main AC
12 power outage and complete battery discharge, the UPS shall automatically restart and
13 assume supplying power to the critical load and the battery charger automatically
14 recharges the battery. This feature shall be capable of being disabled by the user.
- 15 F. If battery is disconnected, the UPS continues to supply power to the load with no
16 degradation of its regulation of voltage and frequency of the output bus.

17 **2.03 DESIGN REQUIREMENTS**

- 18 A. Voltage – The UPS nominal operating voltage shall be as follows:
 - 19 1. Input Voltage: 24 VDC.
 - 20 2. Output Voltage: 24 VDC.
- 21 B. UPS shall be DIN rail-mounted configuration.
- 22 C. Environmental Conditions:
 - 23 1. Ambient temperature range, when UPS is operational, shall be 10°C to 35°C.
 - 24 2. Relative Humidity:
 - 25 a. Operating: 0% to 95% noncondensing.
 - 26 b. Storage: 0% to 95% noncondensing.
 - 27 3. Audible Noise generated by the UPS under normal operation shall not exceed 55 dBA
28 when measured at 1 meter from the surface of the UPS.
 - 29 4. The UPS shall be able to withstand an electrostatic discharge compliant to
30 ENC61000 4-2.

1 **2.04 FABRICATION**

2 A. Materials and components making up the UPS shall be new, of current manufacture and
3 shall not have been in prior service except as required during factory testing.

4 B. Relays shall be provided with dust covers.

5 C. Wiring:

6 1. Wiring practices, materials and coding shall be in accordance with the requirements
7 and standards listed in Section 1.03 and other applicable codes and standards.

8 2. Wiring shall be copper.

9 D. The UPS unit shall be comprised of:

10 1. Battery charger, input filter and internal bypass circuit.

11 2. Batteries consisting of the appropriate number of sealed battery cells.

12 3. The internal battery shall be shipped separately and installed during the UPS
13 installation process.

14 E. The UPS shall be forced air cooled by internally mounted, continuous fans. Fan power
15 shall be provided from the internal DC supply. Air intake shall be through the front of the
16 unit, and air exhaust shall be out of the rear of the unit.

17 **2.05 COMPONENTS**

18 A. Battery Charger:

19 1. The UPS shall contain a three-stage battery charger designed to prolong battery life.

20 2. Recharge time for the internal battery shall be 5 hours to 90% capacity (full discharge
21 rate).

22 3. There shall be DC overvoltage protection so that if the DC voltage exceeds the preset
23 limit, the inverter shall shut down automatically and the critical load shall be transferred
24 to internal bypass.

25 B. Display and Controls:

26 1. General:

27 a. The UPS shall be provided with a microprocessor-based unit status display and
28 controls section designed user operation. The monitoring functions such as voltages,
29 currents, UPS status, and alarm indicators shall be displayed on an LCD display.

30 2. System Indicators:

31 a. The UPS display shall also include LED based system indicators.

- 1 b. The system level indicators shall be:
- 2 1) Fault.
- 3 2) Battery.
- 4 3) Inverter.
- 5 4) ECO mode.
- 6 3. Controls:
- 7 a. UPS startup and shutdown operations shall be accomplished by using push
- 8 buttons on the front panel of the UPS. The display shall be menu driven navigation.
- 9 b. The UPS shall feature an automatic battery test. If the battery fails the test, the
- 10 UPS shall display a warning message to indicate the batteries need to be replaced.
- 11 C. Bypass Circuit:
- 12 1. General:
- 13 a. A bypass circuit shall be provided as an integral part of the UPS. The bypass
- 14 control logic shall contain an automatic transfer control circuit that senses the
- 15 status of the inverter logic signals and operating and alarm conditions. This control
- 16 circuit shall provide a transfer of the load to the bypass source if available and if
- 17 the inverter is capable of powering the load.
- 18 2. Automatic Transfers:
- 19 a. The transfer control logic shall activate the bypass automatically, transferring the
- 20 critical load to the bypass source, after the transfer logic senses one of the
- 21 following conditions:
- 22 1) UPS overload.
- 23 2) UPS over temperature.
- 24 3) DC overvoltage.
- 25 b. Once the overload condition is reduced, the load will be automatically transferred
- 26 back to UPS power.
- 27 c. An over temperature requires manual transfer back to inverter power after cooling.
- 28 D. Battery:
- 29 1. Valve-regulated, nonspillable, lead acid cells shall be used as a stored-energy source
- 30 for the specified UPS system.

- 1 2. Shall be housed internal to the UPS cabinet, with additional batteries housed in
2 matching cabinets.
- 3 3. Sized to support the inverter at rated load and power factor, with ambient temperature
4 of 25°C for a minimum of 3 minutes reserve time.
- 5 4. The expected life of the battery shall be 3 to 5 years or a minimum 260 complete
6 discharge cycles.
- 7 5. The UPS units have the capability to allow the operator to replace the internal battery.
- 8 6. All UPS models shall allow connection of up to six external battery cabinets to provide
9 extended run time capability.

10 E. Output Distribution:

- 11 1. Output distribution shall be hard wired to terminals at the rear of the unit.

12 **2.06 LABELING AND NAMEPLATES**

- 13 A. Nameplates: Identify external door-mounted components and the UPS description with
14 plastic nameplates provided in accordance with Section 26 05 11, "Basic Electrical
15 Methods and Materials."

16 **2.07 GROUNDING**

- 17 A. Provide a grounding lug for Size #2 AWG bare copper conductor.

18 **2.08 FACTORY TESTS**

- 19 A. Provide standard factory tests.
- 20 B. Run each unit through two complete charge-discharge cycles and certify as to having met
21 the applicable criteria.

22 **PART 3 – EXECUTION**

23 **3.01 GENERAL**

- 24 A. The Contractor shall install all equipment per the manufacturer's recommendations and
25 the Drawings.
- 26 B. Hardware to secure the assembly in place shall be provided by the Contractor.
- 27 C. Equipment locations, termination of ground connection, input, output and alarm leads shall
28 be as specified.
- 29 D. Provide ventilation as specified.

1 **3.02 FIELD TESTS**

- 2 A. Provide a factory-authorized service representative to test and commission the UPS and
3 maintenance bypass switch.
- 4 B. Provide manufacturer's written certification verifying proper installation.
- 5 C. After installation, run each unit through one complete charge-discharge cycle utilizing a
6 load bank to verify UPS capability.

7 **END OF SECTION**

1 A. Equipment shall be handled and stored in accordance with manufacturer's instructions.
2 One copy of these instructions shall be included with the equipment at time of shipment.

3 B. Contractor shall store luminaires in dry, temperature-controlled location and provided
4 protection from dust, debris, and moisture while electrical equipment is stored
5 before installation.

6 **1.05 WARRANTY**

7 A. LED luminaire shall come with 5-year manufacturer's warranty.

8 B. Contractor shall complete and provide documentation required for 5-year manufacturer's
9 warranty coverage.

10 **PART 2 – PRODUCTS**

11 **2.01 GENERAL**

12 A. Provide luminaires of type, size, and rating listed in the lighting fixture schedules, complete
13 with, but not necessarily limited to, lamps, lamp holders, drivers, reflectors, starters, wiring,
14 and any other details required for a complete working installation.

15 **2.02 MANUFACTURERS**

16 A. The use of a luminaire manufacturer's name, model, size, or catalog number is for the
17 sole purpose of establishing the standard of quality and general configuration desired.

18 1. See Drawing for specified Lighting Fixture Schedule.

19 B. Acceptable Manufacturers:

20 1. Lithonia.

21 2. Or pre-approved equal.

22 **2.03 LED LUMINAIRES**

23 A. Stainless steel latches.

24 B. Stainless steel surface mounting brackets.

25 C. Unit packaged.

26 D. 5-year warranty.

27 **2.04 LED DRIVER**

28 A. 0–10 V dimming unless otherwise noted.

29 B. MVOLT (120-277 V).

1 **2.05 LED**

2 A. Color temperature of 4000 K unless otherwise noted.

3 **2.06 LIGHTING CONTROL**

4 A. Provide commercial Auto-Off timer switch for lighting control.

5 1. See Section 26 27 26, "Wiring Devices" for Auto-Off timer switch specifications and
6 weatherproof cover.

7 **PART 3 – EXECUTION**

8 **3.01 GENERAL**

9 A. The location, type, and number of luminaires are shown on the Drawings.

10 **3.02 INSTALLATION**

11 A. General:

12 1. Provide conduit, wiring, and fittings as required.

13 2. Luminaires shall be clean and operable at the time of acceptance.

14 3. Align, mount, and level the luminaires uniformly.

15 B. Coordinate with other trades so luminaires are properly aligned.

16 C. Mounting and Supports:

17 1. Mounting heights shall be as shown on the Drawings.

18 a. See the Structural Drawing S3 for lighting mounting brackets underneath the
19 canopy for mounting the two L1 lighting fixtures.

20 b. The flood light, L2 lighting fixture, with yoke bracket shall be mounted to the front
21 canopy structural member so the flood light can be aimed at the wet well.

22 2. Provide bird deterrent spikes on top of light fixtures and mounting brackets to deter
23 birds from roosting.

24 **3.03 TESTING**

25 A. Demonstrate lighting controls to Owner. Demonstrate the Auto-Off timer switch controls
26 the lighting and the lighting is automatically turned OFF after the time interval is complete.

27 **END OF SECTION**

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1 **1.05 SPARE MATERIALS**

2 A. Provide one spare relay for each type of relay installed. Package all spare parts and label
3 all packages with quantity, item description, and part number.

4 **1.06 WARRANTY**

5 A. In addition to the warranty specified in CSI Division 1, the manufacturer's warranty to
6 Owner shall in no event be for a period of less than 2 years starting from when the
7 equipment and installation are substantially complete.

8 B. Warranty shall include repair parts, labor, and travel expenses.

9 **PART 2 – PRODUCTS**

10 **2.01 GENERAL PURPOSE RELAYS**

11 A. Design general purpose relays to operate as follows:

12 1. On application of control power to relay coil, contacts reverse state.

13 2. Contacts return to de-energized state on removal of control power.

14 B. Provide general purpose relays with the following requirements:

15 1. Plug-in blade type.

16 2. Contacts:

17 a. Material: Silver cadmium oxide.

18 b. Rating: Minimum of 10 A at 120 VAC.

19 c. Two Form C, minimum. Provide number of contacts for each relay as required
20 for application.

21 3. Duty Cycle: Continuous.

22 4. Relay sockets with barrier-type screw terminal connections for external wiring:

23 a. Surface or DIN rail mount.

24 b. Relay hold-down clips.

25 5. Lamp indication when relay is energized.

26 6. Acceptable Manufacturers:

27 a. IDEC, RH Series.

28 b. Or approved equal.

1 **2.02 DELAY-ON-MAKE (ON-DELAY) TIME DELAY RELAYS**

2 A. Design delay-on-make time delay relays to operate as follows: On application of voltage
3 to the coil, the relay contacts remain in the “off state” and timing cycle begins. When the
4 set time has elapsed, the relay contacts transfer to the “on state.” The contacts remain in
5 the “on state” until the timer is reset. The timer is reset upon removing the coil voltage.
6 Timer is then ready for the next operation.

7 B. Provide delay-on-make time delay relays with the following requirements:

8 1. Plug-in blade type.

9 2. Repeat Timing Accuracy: Plus or minus 1.5%.

10 3. Minimum Setting: 10% of full range.

11 4. Duty Cycle: Continuous.

12 5. Timing Range: 0.1 seconds–10 minutes.

13 6. Contacts:

14 a. Material: Silver cadmium oxide.

15 b. Rating: 10 A at 120 VAC.

16 c. Two Form C.

17 7. Relay sockets with barrier-type screw terminal connections for external wiring:

18 a. Surface or DIN rail mount.

19 b. Relay hold-down clips.

20 8. Acceptable Manufacturers:

21 a. IDEC, RTE Series.

22 b. Or approved equal.

23 **2.03 DELAY-ON-BREAK (OFF-DELAY) TIME DELAY RELAYS**

24 A. Design delay-on-break time delay relays to operate as follows: Voltage is applied to the
25 coil at all times. When a momentary or maintained start signal is supplied the contacts
26 immediately transfer to “on state.” The set time begins when the start signal is removed.
27 When the set time has elapsed, the contacts transfer to the “off state.” The contacts remain
28 in the “off state” until the next start signal is supplied. The timer can be reset by application
29 of a reset input or by removing coil voltage.

- 1 B. Provide delay-on-energize time delay relays with the following requirements:
- 2 1. Plug-in blade type.
- 3 2. Repeat Timing Accuracy: Plus or minus 1.5%.
- 4 3. Minimum Setting: 10% of full range.
- 5 4. Duty Cycle: Continuous.
- 6 5. Timing Range: 0.1 seconds–10 minutes.
- 7 6. Contacts:
- 8 a. Material: Silver cadmium oxide.
- 9 b. Rating: 10 A at 120 VAC.
- 10 c. Two Form C.
- 11 7. Relay sockets with barrier-type screw terminal connections for external wiring.
- 12 a. Surface or DIN rail mount.
- 13 b. Relay hold-down clips.
- 14 8. Acceptable Manufacturers:
- 15 a. IDEC, RTE Series.
- 16 b. Or approved equal.

17 **2.04 POWER CONTROL RELAYS**

- 18 A. Design power control relays to operate as follows:
- 19 1. On application of control power to relay coil, contacts reverse state.
- 20 2. Contacts return to deenergized state on removal of control power.
- 21 B. Provide power control relay for heavy-duty switching operation with the
- 22 following requirements:
- 23 1. Screw-mounted type with screw type terminals.
- 24 2. Contacts:
- 25 a. Material: Silver cadmium oxide.
- 26 b. Rating: 25 A at 277 VAC, 1 hp per movable arm at 120 VAC.
- 27 c. Two Form C, minimum.

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1 **SECTION 32 31 13**

2 **CHAIN LINK FENCE AND GATES**

3 **PART 1 – GENERAL**

4 **1.01 SCOPE**

5 A. This section covers supply and installation of chain link fence and gates.

6 **1.02 SUBMITTALS**

7 A. Provide submittal data per Section 01 33 00, "Submittal Procedures".

8 B. Manufacturer's data, including installation instructions, shall be submitted for the
9 Engineer's review and approval.

10 **1.03 QUALITY ASSURANCE**

11 A. Chain link fences and gates including necessary erection accessories, fittings, and
12 fastenings shall be supplied by a single manufacturer.

13 **PART 2 – PRODUCTS**

14 **2.01 MATERIALS AND FABRICATION**

15 A. General:

16 1. All items shall be galvanized (zinc-coated) by the hot dip process. Weight of zinc
17 coating shall be determined in accordance with ASTM A90. All items shall include
18 thermal fusion coating of 15 mils of black (color) PVC coated and the fence shall
19 contain black PVC slats in the fabric mesh.

20 2. Pipe for posts, rails, braces, and gate frames shall be Schedule 40 and shall conform
21 to ASTM A120, except the hydrostatic testing requirement is waived. Pipe sizes
22 specified are nominal pipe sizes.

23 3. Hardware and accessories shall conform to ASTM A153.

24 4. Fencing shall be 8 feet high above grade.

25 B. Chain Link Fabric: Fabric shall be 9-gauge steel wire woven in a 2-inch-square mesh with
26 15 mils of black PVC coating over 0.3 ounces zinc substrate with an 850-pound breaking
27 strength. Fabric shall be 96 inches in height and shall be furnished in one-piece widths.
28 Fabric shall be knuckled on the bottom selvage and twisted on the top selvage. Fabric shall
29 conform to ASTM A392 and shall be galvanized after fabrication. The zinc coating shall be
30 applied in a continuous process and shall not be applied to the fabric in roll form. The weight
31 of zinc coating shall not be less than 1.2 ounces per square foot of actual surface covered.
32 Use 9-gauge black PVC coated tie wires at not more than 24-inch spacing.

- 1 C. Line Posts: Line posts shall be 2-inch-diameter schedule 40 steel pipe with galvanized
2 and black PVC coating. The weight of the zinc coating shall not be less than 1.8 ounces
3 per square foot of actual surface covered.
- 4 D. End, Corner, and Pull Posts: End, corner, and pull posts shall be 3-inch-diameter schedule
5 40 steel pipe with galvanized and black PVC coating. The weight of zinc coating shall not
6 be less than 1.8 ounces per square foot of actual surface covered.
- 7 E. Gate Posts: Gate posts shall be 3-1/2-inch-diameter schedule 40 steel pipe with
8 galvanized and black PVC coating. The weight of zinc coating shall not be less than
9 1.8 ounces per square foot of actual surface covered.
- 10 F. Top Rails: Top rails shall be 1-1/2-inch-diameter schedule 40 steel pipe with galvanized
11 and black PVC coating. Weight of zinc coating shall not be less than 1.8 ounces per
12 square foot of actual surface covered. Top rails shall be in lengths not less than twice the
13 line post spacing and shall be fitted with sleeve-type couplings for connecting the lengths
14 into a continuous run. Couplings shall be a minimum of 6 inches long, with a
15 0.070 minimum wall thickness, and shall allow for expansion and contraction of the rail.
16 The top rail shall pass through the line posts, forming a continuous brace for each stretch
17 of fence. The top rail shall be secured to end, pull, corner, and gate posts with suitable
18 fittings.
- 19 G. Post Braces:
- 20 1. Post braces shall be 1-1/2-inch-diameter schedule 40 steel pipe with galvanized and
21 black PVC coating. Weight of zinc coating shall not be less than 1.8 ounces per square
22 foot of actual surface covered. Post braces shall be provided for each end, pull, corner,
23 and gatepost, and shall extend to each adjacent line post at approximately mid-height
24 of the fabric. A truss consisting of a steel rod not less than 3/8-inch nominal diameter
25 with a turnbuckle or other adjustable tightener shall extend from the line post back to
26 the gate, corner, pull, or end post.
- 27 2. Truss rods may be eliminated in any line of fence where there is a continuous center rail.
- 28 H. Post Tops: Weather-tight closure tops shall be provided for each post. Post tops shall fit
29 over the outside of posts and shall have openings suitable for the through passage of the
30 top rail. Post tops shall be steel with galvanized and black PVC coating.
- 31 I. Tension Bars: Tension bars shall be steel with galvanized and black PVC coating with a
32 minimum cross section of 3/16 inch by 3/4 inch and shall be one-piece lengths equal to
33 the full height of the fabric. One tension bar shall be provided for each end and gatepost;
34 two tension bars shall be provided for each corner and pull post.
- 35 J. Tension Bands: Bands shall be provided for securing tension bars and fabric to end,
36 corner, pull, and gateposts. Bands shall be spaced not more than 15 inches on centers.
37 Bands shall be fabricated from steel with galvanized and black PVC coating.
- 38 K. Ties and Clips: Ties or clips shall be provided for attaching the fabric to line posts, rails,
39 and braces. Ties shall be spaced 12 inches on center for attaching fabric to line posts; ties
40 shall be spaced 24 inches on center for attaching fabric to rails and braces. Ties shall be
41 black PVC coated.

- 1 L. Tension Wires: Tension wire shall be 7-gauge steel coil wire with galvanized and black
2 PVC coating. Weight of zinc coating shall not be less than 0.80 ounces per square foot of
3 uncoated wire surface.
- 4 M. Gates:
- 5 1. Slide gate perimeter frames shall be fabricated from 2-inch-diameter schedule 40 steel
6 pipe with galvanized and black PVC coating. Swing (man) gate perimeter frames shall
7 be fabricated from 1-1/2-inch-diameter schedule 40 steel pipe with galvanized and
8 black PVC coating. Gate frames shall be welded at all corners or assembled with
9 fittings. Welds shall be painted with zinc-based paint prior to applying the black PVC
10 coating.
- 11 2. Gate fabric shall be the same as that used for fence. Fabric shall be attached securely
12 to the gate frame at intervals not exceeding 15 inches. Fabric shall be installed with
13 stretcher bars at all four edges. Gates shall have 3/8-inch-diameter diagonal,
14 galvanized steel with black PVC coating adjustable truss rods to prevent sag or twist.
- 15 3. End members of the gate frames shall extend to the top horizontal member.
- 16 4. Slide gate shall include double wheel carrier, rear wheels with brackets, pipe track
17 brackets, tubing for track, horizontal and vertical bracing, and all other accessories
18 required for functional gate. Materials shall be steel with galvanized and black PVC
19 coating.
- 20 5. Gate shall have lockable latches.
- 21 N. Gate Hardware:
- 22 1. Gate hardware shall be galvanized steel with black PVC coat. Field coat moveable
23 parts (e.g., hinges, latch, keeper, and drop bar) with touch up PVC paint, provided by
24 manufacturer, to match adjacent finishes.
- 25 2. Each swing gate leaf shall have one and one-half pair of hinges. Non-lift-off type
26 hinges shall permit gate to be opened 180 degrees.
- 27 3. Latches shall be forked type or plunger-bar type to permit operation from either side
28 of gate. Latches shall have a padlock eye as an integral part.
- 29 4. Gate stops shall be provided for the slide gates. Gate stops shall be set in concrete
30 and shall stop the gate in both the open and closed positions.
- 31 O. Plastic Slats:
- 32 1. Black plastic slats shall be installed in all portions of the fence including gates.
- 33 2. Plastic slats shall be 1.44-inches in width by the height designation of the fence to
34 achieve a minimum coverage or privacy factor of 90%. They shall be manufactured
35 from tubular polyethylene color pigmented material consisting of high-density virgin
36 polyethylene and color pigments, designed to retard ultraviolet penetration. The
37 material shall remain flexible without distortion and without becoming brittle through a

- 1 temperature range of -75°F to +190°F. Tube tensile strength shall be at least 4,000 psi.
2 Slats shall be Black Solitube slat or approved equal.
- 3 3. Plastic slats shall be retained in place by means of U-shaped retainer members at the
4 bottom of the fence. Retainer members shall be of the same material and manufacturer
5 as the slats.
- 6 P. Miscellaneous Fittings and Hardware: Fittings and hardware not specifically mentioned,
7 but required for assembly of the fence and gates shall be steel with galvanized and
8 PVC coatings.
- 9 Q. Concrete: Concrete for footings shall have a 28-day compressive strength of 3,000 psi.

10 **PART 3 – EXECUTION**

11 **3.01 INSTALLATION**

- 12 A. Fence and gates shall be installed after final grading is complete.
- 13 B. Care shall be taken not to damage the galvanizing and PVC coating on fencing materials.
14 Any areas damaged shall be repaired with an approved applicable coating.
- 15 C. Posts shall be plumb and the fence line shall be straight between the corner posts. Posts
16 shall be uniformly spaced. The maximum spacing between posts shall be 10 feet. Where
17 the ground slopes, the fence shall follow a uniform grade so that there is no sharp dip or
18 rise in the fence profile. The bottom of the fence shall be 2 inches above finished grade.
- 19 D. Each footing shall be crowned to shed water away from the post.
- 20 E. A tension wire shall be stretched taut from post to post along each section of fence within
21 the bottom 6 inches of the fabric. The tension wire shall be securely tied to each post.
- 22 F. Fabric shall be free of kinks and shall be properly stretched so there is no sagging or
23 bulging. Fabric shall be placed on the outside of the area enclosed. Fabric shall be
24 attached to line posts at 12-inch intervals and to the top rail, tension wire, and braces at
25 24-inch intervals.
- 26 G. Gates shall be installed plumb and level. When installed, gates shall be tested for ease of
27 operation and proper closure and locking. Hardware shall be adjusted and lubricated
28 where necessary for ease of operation.
- 29 H. All fencing installed for this project shall be grounded.

30 **END OF SECTION**

- 1 B. Instrumentation Society of America (ISA) Publications:
- 2 1. S5.4 Instrument Loop Diagrams.
- 3 2. S20 Specification Forms for Process Measurement and Control Equipment,
4 Primary Elements and Control Valves.
- 5 C. Manufacturer's data sheets, materials selection, and installation guidelines for the
6 instrumentation specified in these Specifications and Drawings.

7 **1.03 QUALIFICATIONS**

- 8 A. The Contractor shall be an entity that has completed similar utility projects and who has
9 demonstrated experience in purchasing, calibrating, fabricating, installing, and testing the
10 equipment listed in this specification section.
- 11 B. The Contractor shall have at least 5 years of experience in performing all aspects of the
12 type of work specified in this section and shown on the Drawings.

13 **1.04 CONTRACTOR AND SUBCONTRACTOR SYSTEM RESPONSIBILITIES**

- 14 A. General: The equipment as specified in this division shall be considered an integrated
15 system. Entire system installation including calibration, verification, startup, operation
16 testing, and training shall be performed by qualified personnel, possessing all the
17 necessary skills and equipment, and who have had experience performing similar
18 installations. Entity responsibilities include:
- 19 1. Contractor: To obtain technical data, determine performance requirements, develop
20 detail installation designs, and coordinate the selection of specified equipment to meet
21 the design conditions stated.
- 22 2. Hardware System Integrator (HSI): Refer to Section 40 68 13.
- 23 3. Software System Integrator (SSI): Refer to Section 40 68 13.
- 24 B. System Responsibilities:
- 25 1. Technical: Obtain technical data, determine performance requirements, develop
26 installation details and integrate supplied equipment where depicted on the Drawings.
- 27 2. Compatibility: See that components of the process system, including equipment
28 specified under other divisions, are compatible and function properly as a system.
29 Provide such additional equipment, accessories, etc., as are necessary to meet these
30 objectives at no cost to the Owner.
- 31 3. Coordination: For control components, devices, and systems specified in other
32 divisions, or shown on the Drawings.
- 33 a. Provide technical advice to mechanical and electrical subcontractors as necessary
34 regarding their installation of equipment.

- 1 b. Verify the correctness of installation of all equipment.
- 2 c. Verify that the proper type, size, and number of control wires with their conduits
3 are provided.
- 4 d. Verify that proper electric power circuits are provided for all components and
5 systems.
- 6 e. Resolve all manufacturers' installation discrepancies between requirements and
7 the detail requirements of the Drawings and Specifications.
- 8 f. Supervise final signal connections, all process instrumentation and control
9 equipment.
- 10 g. Adjust, startup, and test all process instrumentation and control equipment.
- 11 h. Provide specified documentation and training.
- 12 4. Performance: While the Drawings provide sufficient information to establish the form
13 and function of the systems and their relationships, the responsibility for system
14 integration and performance rests solely with the Contractor. The Engineer provides
15 technical instruction and guidance where needed.
- 16 5. Site and Instrument Inspection: Inspect site for conformance to Drawings, paying
17 special attention to space allocation and dimensions shown or required on Drawings.
18 Inspect completed work and verify that it is ready for installation of equipment. Inspect
19 each piece of equipment for damage, defects, completeness, and correct operation
20 before installing.

21 **1.05 SUBMITTALS**

- 22 A. Shop Drawings: Submit shop drawings (diagrams) for review in complete, searchable,
23 PDF sets indexed by specification number, with tabs marked by subject. Submit
24 manufacturer's catalog cuts for each item for which shop drawings are not required.
25 Manufacturer's catalog cuts, specifications, or data sheets shall be clearly marked to
26 delineate the options or styles to be furnished. Show dimensions, physical configurations,
27 methods of connecting equipment together, mounting details, and wiring schematics.
28 Drawings shall be complete with device tag numbers, wire numbers, and terminal board
29 numbers. Submit fabrication details, nameplate legends, and control panel internal wiring
30 and piping schematic drawings. Submit panel graphic drawings where applicable. Include
31 material lists and/or bills of material.
- 32 B. Record Drawings: Submit a revised set of shop drawings that incorporates all change
33 orders and modifications made during performance of the work. In addition, submit
34 equipment and device installation diagrams and other drawings as necessary to depict the
35 "as-constructed" condition of equipment. Include all installed field and panel conduit and
36 piping/tubing runs and routing, tray systems, supports, mounting details, interconnection
37 diagrams with cable, wire, tube, and termination numbers. Submit a copy of CAD-produced
38 drawings in AutoCAD DWG format via email.

- 1 C. Operation and Maintenance Manuals: Furnish Operation and Maintenance Manuals,
2 including Instruction Manuals and Part Lists, for equipment provided under CSI
3 Division 40. Obtain data from manufacturers, and format and bind as specified. Obtain
4 distribution method instructions from the Owner or Owner's representative.
- 5 1. Schedule: Deliver at least two copies of manuals in 3-ring binders (8-1/2 by 11-inch
6 format) and one electronic copy not later than the equipment shipment date.
- 7 2. Contents: Include in manuals not less than the following information, as applicable, for
8 each process equipment, subsystem and/or packaged systems:
- 9 a. General, introduction and overall description, purpose, functions, simplified theory
10 of operations, etc.
- 11 b. Specifications (including equipment specification data sheet as described above
12 under Shop Drawings), sufficiently detailed for reordering exact duplicates of the
13 original items.
- 14 c. Installation instructions, procedures, sequences, tolerances, and precautions.
- 15 d. Operational procedures.
- 16 e. Shutdown procedures.
- 17 f. Maintenance, calibration, and repair instructions.
- 18 g. Parts list and spare parts recommendations.
- 19 h. Calibration curves, rating tables, and any other data showing the relationship of
20 the variable inputs and the calibrated output of all measuring devices and
21 controlled equipment.
- 22 3. Format:
- 23 a. Use drawings and pictorials to illustrate the text to the extent necessary to ensure
24 a clear, concise presentation. If manuals have been written to cover a family of
25 similar equipment or equipment, strike out inapplicable information in a neat
26 fashion or emphasize applicable portion by heavily weighted arrows, circles, or
27 boxes; whichever provides the clearest and neatest presentation.
- 28 b. Group manuals by system control panels, including field instrumentation
29 connected or associated with the panel. Where identical equipment is used in more
30 than one control loop or subsystem, include only one instruction manual, per panel
31 grouping; however, an index by tag number for all equipment shall identify its
32 location in that manual.
- 33 c. Provide control loop and/or subsystem operational descriptions to identify the
34 function of each instrument and its relation to the other equipment in the loop.
- 35 4. Binding: Bind each manual in a cover which indicates the panel or process area to
36 which it applies, manufacturer's name, local address and telephone number, and year

1 of purchase. Punch and bind (with plastic reinforced edges) manuals in standard three-
2 ring binders and include system name and subcontractor's name on binding.

3 D. Accessory and Maintenance Materials: Submit data for the following items:

4 1. Special Tools and Accessories: Special tools, equipment, and accessories for
5 maintaining equipment and equipment requiring periodic repair and adjustment as
6 specified elsewhere herein. Also, furnish special lifting and handling devices for
7 equipment requiring such devices.

8 2. Maintenance Materials and Spare Parts: Submit a list of manufacturer-recommended
9 spare parts for each item specified. Refer to other sections of these Specifications.

10 E. Demonstration and Final Operation Test Plan and Results: Submit a document that
11 outlines all procedures to be used in final operational testing of instrument and control
12 systems. Include a description of each system, the scope of testing, test methods and
13 materials, testing equipment and recorders, a list of functional parameters to be recorded
14 on each item, and shop drawings showing temporary bypasses, jumpers, and devices.

15 **1.06 QUALITY ASSURANCE**

16 A. Standard of Quality: The Contractor shall provide equipment of the types and sizes
17 specified which has been demonstrated to operate successfully. Provide equipment which
18 is new and of recent proven design.

19 **1.07 INSPECTIONS**

20 A. The Engineer may inspect the fabricated equipment at the factory before shipment to job
21 site. Provide the Engineer with 2-week prior written notice (preferably e-mail) so that an
22 inspection can be arranged at the factory.

23 B. Inspection of the equipment at the factory by the Engineer will be made after the
24 manufacturer has performed satisfactory checks, adjustments, tests, and operations.

25 C. Favorable review of the equipment at the factory only allows the manufacturer to ship the
26 equipment to the project site. The Contractor shall be responsible for the proper installation
27 and satisfactory startup operation of the equipment to the satisfaction of the manufacturer
28 and the Engineer.

29 **1.08 PRODUCT DELIVERY, STORAGE, AND HANDLING**

30 A. Box, crate, or otherwise enclose and protect equipment and equipment during shipment,
31 handling, and storage. Keep all equipment dry and covered from exposure to weather,
32 moisture, corrosive liquids and gases or any element that could degrade the equipment.
33 Protect painted surfaces against impact, abrasion, discoloration, and other damage. Notify
34 the Engineer in writing in the event that any equipment or material is damaged. Obtain
35 prior favorable review of the Contractor/manufacturer proposed Replacement/Repair by
36 the Engineer before making repairs to or replacing damaged products.

1 **1.09 SEISMIC ANCHORAGE AND STRUCTURAL DATA**

2 A. Mechanical, instrumentation and control, electrical, nonstructural systems, components,
3 and elements permanently attached to the structure shall be anchored and braced to resist
4 seismic forces.

5 **1.10 WARRANTY**

6 A. Warranty shall include parts, labor, and travel expenses necessary for repairs at the job
7 site.

8 B. Unless otherwise indicated, minimum warranty duration shall be 1 year from the Final
9 Acceptance Date.

10 C. Contractor shall provide warranty equivalent to the manufacturer's warranty period
11 beginning on the issue date of the certificate of substantial completion.

12 **PART 2 – PRODUCTS**

13 **2.01 MATERIALS AND STANDARD SPECIFICATIONS**

14 A. Provide equipment, equipment, and materials suitable for service conditions and meeting
15 standard specifications such as ANSI, ASTM International (ASTM), etc. The intent of this
16 specification is to secure equipment and equipment of a uniform quality and manufacture
17 throughout the Owner's facility. All equipment in the plant of the same type shall be made
18 by the same manufacturer.

19 B. For any approved substitutions, it is the responsibility of the Contractor to adhere to the
20 requirements of the substituted equipment's manufacturer's installation requirements and
21 these Specifications. If the manufacturer's installation requirements conflict with these
22 Specifications/Drawings in such a way that the as designed Specifications/Drawings may
23 void the substituted equipment manufacturer's warranty or diminish the functionality of the
24 equipment and or process, the manufacturer's requirements shall prevail.

25 **2.02 NAMEPLATES**

26 A. For each piece of equipment, provide a manufacturer's nameplate showing the
27 manufacturer's name, location, the pertinent ratings, and the model designation.

28 B. Identify each piece of equipment and related controls with a rigid laminated engraved
29 plastic nameplate (Refer to Section 26 05 53 for specific requirements). Engrave
30 nameplates with the inscriptions indicated on the Drawings and, if not so indicated, with
31 the equipment name. Securely fasten nameplates in place using two stainless steel
32 screws or, where favorably reviewed by the Engineer, with epoxy cement. Where no
33 inscription is indicated on the Drawings, furnish nameplates with an appropriate inscription
34 furnished by the Engineer upon prior request by the Contractor.

- 1 C. Each control device, including pushbuttons, control switches, and indicating lights, shall
2 have an integral legend plate or nameplate indicating the device function. These shall be
3 inscribed as indicated on the Drawings or as favorably reviewed by the Engineer.
- 4 D. Provide CAUTION or SAFETY nameplates to alert operators of special conditions that
5 may result in faulty equipment operations. Devices containing batteries that must be
6 replaced periodically must be clearly identified. Nameplates are not required if the device
7 senses and displays a low battery warning.

8 **2.03 NAME TAGS**

- 9 A. All instrumentation and equipment items or systems shall be identified by name tags. Field
10 equipment shall be tagged with the assigned instrumentation tag number listed in the
11 Instrumentation Schedule. Refer to Section 40 70 00.01.
- 12 B. Name tags shall be stainless steel with engraved or stamped black characters of
13 3/16-inch-minimum height. Tags shall be attached to equipment with a tag holder and
14 stainless steel band with a worm screw clamping device. Use 20-gauge stainless steel
15 wire where banding is impractical. For field panels or large equipment cases use stainless
16 steel screws; however, such permanent attachment shall not be on an ordinarily
17 replaceable part.

18 **2.04 FIELD-MOUNTED EQUIPMENT**

- 19 A. All instrument and control equipment mounted outside of protective structures shall be
20 equipped with suitable surge arresting devices to protect the equipment from damage due
21 to electrical transients induced in the interconnecting lines from lightning discharges or
22 nearby electrical devices. Protective devices used on 120 VAC inputs to field mounted
23 equipment shall be secondary surge protectors conforming to the requirements of
24 ANSI C62.1.

25 **2.05 EQUIPMENT LOCATIONS**

- 26 A. Provide equipment and materials suitable for the types of locations in which they are
27 located as defined under CSI Division 40. All equipment specified for field mounting shall
28 be weatherproof and splash proof as a minimum. If electrical or electronic components
29 are contained within the equipment, they shall be housed in NEMA 3R gasketed cases,
30 and NEMA 4X in corrosive locations unless noted otherwise on the Drawings or specific
31 item specification.

32 **2.06 PAINTING**

- 33 A. Factory paint all equipment and equipment except where installed in pipelines. Repair
34 damaged factory paint to satisfaction of the Engineer. Feathering, priming, and painting
35 shall produce a reasonable match to the surrounding paint work.

36 **2.07 FASTENERS**

- 37 A. Fasteners for securing equipment to walls, floors, and the like shall be either hot-dip
38 galvanized after fabrication or stainless steel. Provide stainless steel fasteners in corrosive
39 locations. When fastening to existing walls, floors, and the like, provide capsule anchors,

1 not expansion shields. Size capsule anchors to meet load requirements. Minimum size
2 capsule anchor bolt is 3/8 inch.

3 **2.08 TUBING, PIPE, FITTINGS AND SUPPORTS**

4 A. General: Instrument tubing listed below is required for all equipment and control valves.
5 Select the appropriate tubing materials to satisfy service conditions except where
6 specifically shown on Installation Detail Drawing.

7 1. Stainless Steel: Stainless tubing shall be Type 304 seamless, cold drawn and
8 annealed per ASTM A269. Sizes shall be 1/4-inch O.D. by 0.045-inch wall, 3/8-inch
9 O.D. by 0.035-inch wall or 1/2-inch O.D. by 0.035-inch wall. Use for instrument or valve
10 connections.

11 2. Fittings:

12 a. Stainless Steel Tube: Threaded tube and pipe shall be Type 304 stainless.
13 Compression fittings shall be Type 316 stainless steel equal to Imperial or
14 Swagelok.

15 b. Supports for Tubing: Supports located in areas exposed to the weather or corrosive
16 atmosphere shall be Type 304 stainless steel Unistrut or equal or made of steel
17 conforming to ASTM A276. Supports not exposed to the weather or corrosive
18 atmosphere shall be carbon steel painted.

19 c. Weld joint fittings shall be permitted for header and branch service only. Use unions
20 only as necessary to simplify instrument removal.

21 3. Valves:

22 a. Instrument valves shall be 1/4 inch, 3/8 inch, or 1/2 inch from Whitey or Hoke to
23 match tubing material and size.

24 **2.09 INSTRUMENT CALIBRATION**

25 A. Each field instrument shall be calibrated at 0%, 25%, 50%, 75%, and 100% of span using
26 test equipment to simulate inputs and read outputs that are rated to an accuracy of at least
27 five times greater than the specified accuracy of the instrument being calibrated. Such test
28 equipment have accuracies traceable to the National Institute of Standards and
29 Technology (NIST).

30 B. Submit a written report to the Engineer on each instrument. This report shall include a
31 laboratory calibration sheet or the manufacturer's standards calibration sheet on each
32 instrument and calibration reading as finally adjusted within tolerances.

33 C. The Contractor shall contract with the manufacturer's qualified test representative to
34 perform calibration on supplied instrumentation.

1 **2.10 FACTORY TESTING**

- 2 A. All fabricated equipment shall be tested before it leaves the factory. At the factory verify
3 wiring continuity and equipment operation by simulating input and output.
- 4 B. Factory testing of control panels/devices/equipment shall be completed, documented and
5 provided to the Owner/Engineer for favorable review prior to shipping. Refer to individual
6 specification sections for tests requiring favorable review. Testing shall be performed in an
7 8-hour day by the Hardware Systems Integrator.
- 8 C. Upon completion of factory testing, submit a report certifying the control
9 panels/devices/equipment are operable and meet the Specifications.

10 **PART 3 – EXECUTION**

11 **3.01 MOUNTINGS**

- 12 A. Mount and install equipment as indicated on the Drawings or as required by the
13 manufacturer. Mount field equipment on pipe mounts or other similar means in accordance
14 with manufacturer's recommendation. Where mounted in control panels, mount according
15 to requirements of that section.
- 16 B. Equipment specified for field mounting shall be suitable for direct pipe mounting or surface
17 mounting.
- 18 C. All devices shall be accessible to operators for servicing, operating, reading, etc. Provide
19 permanent platforms to ensure that devices are accessible.

20 **3.02 ELECTROMAGNETIC INTERFERENCE (EMI)**

- 21 A. Construction shall proceed in a manner which minimizes the introduction of noise
22 (RFI/EMI) into the Process Control System and associated components/devices.

23 **3.03 PREPARATION**

- 24 A. Ensure that installation areas are clean and that concrete or masonry operations are
25 completed prior to installing equipment and equipment. Maintain the areas in a
26 broom-clean condition during installation operations.
- 27 B. Equipment shall be protected during shipping, storage, and construction to prevent
28 damage and prevent dust accumulation. Other protective measures (lamp, strip heaters,
29 shaft rotation, etc.) shall be included as required by the manufacturer.

1 **3.04 PERFORMANCE TESTING AND OPERATIONAL TESTING**

2 A. General: The purpose of the field testing is to verify equipment are calibrated and
3 operationally performing their intended function. Provide the services of factory trained and
4 experienced engineers to perform verification and operational testing as prescribed below.
5 Since the initial calibration of equipment may not satisfy the final operation of system,
6 perform recalibration or adjust setpoints as required to satisfy the performance requirements
7 of the system. Notify the Engineer and Owner in writing a minimum of 48 hours prior to the
8 proposed date for commencing final operational testing and acceptance.

9 B. During Process System Verification:

- 10 1. Make initial or provisional settings on levels, alarms, etc. listed in the Instrument Schedule.
- 11 2. PID Loops: Verify controllers by observing that the final control element moves in the
12 proper direction to correct the process variable as compared to the set point.
- 13 3. Cause malfunctions to sound alarms or switch to standby to check system operation.
- 14 4. Check all loop equipment thoroughly for correct operation.
- 15 5. Immediately correct all defects and malfunctions disclosed by tests.
- 16 6. Submit a report certifying completion of verification of each process system. This
17 report shall include a data sheet on each piece of equipment tested that indicates
18 equipment tolerances, calibration verification, data, and initial settings made to
19 equipment and devices.

20 C. Operational Testing and Tuning: Upon completion of equipment verification, test all
21 systems under process conditions in the presence of the Owner or designated
22 representative. System testing shall be accomplished in accordance with the Engineer
23 approved Test Plan. The test for each portion thereof shall be witnessed, documented,
24 and signed off upon completion by the Engineer. The intent of this test is to demonstrate
25 and certify the operational interrelationship of process equipment, instrumentation, and
26 control systems. This testing shall include, but not be limited to:

- 27 1. Making final adjustments to levels, alarms, etc.
- 28 2. Optimum tuning of controllers.
- 29 3. Checking all alarms, failure interlocks, and operational interlocks.
- 30 4. Verifying all PLC and computer input and outputs and operator interface terminal (OIT)
31 displays are fully functional.
- 32 5. Verifying automatic computer-generated reports are performing satisfactorily.
- 33 6. Immediately correcting all defects and malfunctions and retesting.

1 7. Submit the witnessed test results and a transmittal letter indicating that all required
2 systems have been tested satisfactorily and the systems meet all the functional
3 requirements of their applicable specifications.

4 8. Sampling of process streams to ensure automated processes meet the requirements.

5 **3.05 INSTRUCTION OF OWNER'S PERSONNEL**

6 A. Provide the services of a factory trained and field experienced instrumentation Engineer
7 to conduct group training of the Owner's designated personnel in the operation of each
8 piece of equipment. This training shall be for the time period of up to 1 working day and
9 shall be performed during the operational testing period. Include instruction covering basic
10 system theory, operating principles and adjustments, routine maintenance and repair, and
11 "hands on" operation. The text for this training shall be the Operation and Maintenance
12 Manuals furnished under these Specifications.

13 **END OF SECTION**

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1 **SECTION 40 61 93**

2 **PROCESS CONTROL SYSTEM INPUT/OUTPUT LIST**

3 **PART 1 – GENERAL**

4 **1.01 SUMMARY**

5 A. Provide input/output (I/O) connections to programmable logic controllers (PLC) as shown
6 on the Drawings, in the attached PLC I/O list that follows this section, and as needed for
7 a complete and proper installation.

8 B. Provide I/O connections for PCP-01.

9 C. Related Work: Documents affecting work under this section include but are not necessarily
10 limited to the Technical Specifications and Drawings.

11 **1.02 SUBMITTALS**

12 A. Hardware System Integrator shall submit final I/O list identifying all electrical connections
13 have been made.

14 **1.03 QUALITY ASSURANCE**

15 A. It is the Hardware System Integrator's responsibility to verify the existing wire numbers,
16 terminal numbers and configuration of equipment. Note information in submittals, final
17 as-built, and O&M documents.

18 **PART 2 – PRODUCTS (NOT USED)**

19 **PART 3 – EXECUTION**

20 **3.01 GENERAL**

21 A. Four original Equipment and I/O spreadsheets are available upon request.

22 B. The fonts shown on the Equipment and I/O lists denote:

23 1. Black font for new connections items.

24 2. Gray font for future connections not part of this Contract.

25 **(PLC I/O LIST FOLLOWS)**

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Eq ID	Equip Name	Location	Point Name	24 VDC DI	24 VDC DO	24 VDC AI
P-001	WET WELL PUMP 1 HOA	PCP-101	IN HAND	X		
P-001	WET WELL PUMP 1 HOA	PCP-101	IN AUTO	X		
P-001	WET WELL PUMP 1 CONTACTOR	PCP-101	MOTOR RUNNING	X		
P-001	WET WELL PUMP 1 OVERLOAD	PCP-101	MOTOR FAULT	X		
P-001	WET WELL PUMP 1 RELAY	PCP-101	MOTOR OVERTEMP	X		
P-001	WET WELL PUMP 1 RELAY	PCP-101	PUMP SEAL LEAK	X		
P-001	WET WELL PUMP 1 CONTACTOR	PCP-101	CALL TO RUN FROM PLC		X	
P-002	WET WELL PUMP 2 HOA	PCP-101	IN HAND	X		
P-002	WET WELL PUMP 2 HOA	PCP-101	IN AUTO	X		
P-002	WET WELL PUMP 2 CONTACTOR	PCP-101	MOTOR RUNNING	X		
P-002	WET WELL PUMP 2 OVERLOAD	PCP-101	MOTOR FAULT	X		
P-002	WET WELL PUMP 2 RELAY	PCP-101	MOTOR OVERTEMP	X		
P-002	WET WELL PUMP 2 RELAY	PCP-101	PUMP SEAL LEAK	X		
P-002	WET WELL PUMP 2 CONTACTOR	PCP-101	CALL TO RUN FROM PLC		X	
LSLL-001	FLOAT SWITCH CR5-1	PCP-101	WET WELL LOW LOW LEVEL SWITCH	X		
LSL-001	FLOAT SWITCH CR6-1	PCP-101	WET WELL LOW LEVEL SWITCH	X		
LSH-001	FLOAT SWITCH CR7-1	PCP-101	WET WELL HIGH LEVEL SWITCH	X		
LSHH-001	FLOAT SWITCH CR8-1	PCP-101	WET WELL HIGH HIGH LEVEL SWITCH	X		
NA	120 VAC POWER CR1A-1	PCP-101	120 V POWER AVAILABLE	X		
NA	24 VDC UPS	PCP-101	UPS ALARM	X		
NA	24 VDC POWER CR1-1	PCP-101	24 VDC POWER AVAILABLE	X		
ZS-001	WET WELL HATCH SWITCH	WET WELL	WET WELL INTRUSION	X		
ZS-102	PUMP STATION GATE SWITCH	PUMP STATION GATE	PUMP STATION INTRUSION	X		
FIT-001	MAGNETIC FLOW METER	VALVE VAULT	EFFLUENT FLOW RATE			X
	SPARE			X		
	SPARE			X		
	SPARE			X		
	SPARE			X		
	SPARE			X		
	SPARE			X		
	SPARE				X	
	SPARE				X	
	SPARE					X
	SPARE					X

34	I/O Total by Type Count ----->	27	4	3	34
	Points per module	16	8	8	
	Min Number of Modules reqd	1.6875	0.5	0.375	
	Installed number of modules	2	1	1	

END OF SECTION

1 **SECTION 40 62 63**

2 **OPERATOR INTERFACE TERMINALS (OIT)**

3 **PART 1 – GENERAL**

4 **1.01 SUMMARY**

- 5 A. Provide Operator Interface Terminals (OIT), also referred to as a Human Machine
6 Interface (HMI), as shown on the Drawings, as specified herein, and as needed for a
7 complete and proper installation.

8 **1.02 SUBMITTALS**

- 9 A. Submit shop drawings in compliance with pertinent provisions of Section 40 61 13,
10 including the manufacturer’s detailed specifications.
- 11 B. Submit manufacturer’s product information and data sheet for all products.
- 12 C. Submit operation and maintenance (O&M) manuals in compliance with pertinent
13 provisions of Section 40 61 13.

14 **1.03 QUALITY ASSURANCE**

- 15 A. All PLC and HMI equipment to be provided by one manufacturer.

16 **1.04 DELIVERY, STORAGE, AND HANDLING**

- 17 A. Comply with pertinent provisions of Section 40 61 13.

18 **1.05 SPARE MATERIALS**

- 19 A. Provide on spare OIT for each type/model of OIT supplied under these Specifications and
20 Drawings.

21 **1.06 WARRANTY**

- 22 A. Refer to Section 40 61 13 for Contractor-supplied equipment warranty requirements.

23 **PART 2 – PRODUCTS**

24 **2.01 GENERAL**

- 25 A. Design panel-mounted HMI graphics and programming to allow for monitoring and control
26 of the provided equipment.

1 **2.02 PANEL-MOUNTED HMI**

2 A. Provide panel-mounted HMI with the following requirements:

- 3 1. Display Type: Color Active Matrix Thin Film Transistor (TFT) with LED backlight.
- 4 2. Display Size: 7-inch diagonal, minimum.
- 5 3. Operator Input: Resistive touch-screen.
- 6 4. Communication Port: Ethernet or other industrial protocol as shown on the Drawings.
- 7 5. Memory: As required for application.
- 8 6. Real Time Clock: Backed up for 30 days, minimum.
- 9 7. Power: 24 VDC.
- 10 8. Operating Temperature: 0°C to 50°C.
- 11 9. Rating: NEMA4X, IP65.
- 12 10. Certifications: UL Listed.
- 13 11. Cables to connect to communication network.
- 14 12. Conformal coating is acceptable.
- 15 13. Acceptable Manufacturers:
 - 16 a. Allen-Bradley PanelView 5510 Series.
 - 17 b. Approved Equal.

18 **PART 3 – EXECUTION**

19 **3.01 INSTALLATION**

- 20 A. Install HMI in accordance with manufacturer’s recommendations.
- 21 B. Configure the HMI in accordance with manufacturer’s instructions, and as shown on the
- 22 Drawings.

23 **3.02 FUNCTIONAL TESTING AND COMMISSIONING**

- 24 A. Coordinate functional testing and commissioning with Section 40 63 43. The entire system
- 25 shall be tested and commissioned as a completed system.

1 **3.03 TRAINING**

2 A. The Contractor's HSI shall provide one-half day of training for the OIT hardware. This
3 training shall demonstrate the manufacturer's specific requirements for installation,
4 operation and maintenance. Refer to Section 40 68 13.

5 **END OF SECTION**

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1 **1.06 SPARE MATERIALS**

2 A. Provide the following number of spare parts to the Owner that match items specified:

- 3 1. One spare processor unit for each unique processor installed.
- 4 2. One spare I/O module for each unique I/O module type installed.
- 5 3. One spare communication module for each unique communication module installed.
- 6 4. One spare power supply for each unique power supply installed.
- 7 5. One spare SD card.

8 B. Package all spare parts and label all packages with quantity, item description, and part
9 number.

10 **1.07 WARRANTY**

11 A. Refer to Section 40 61 13 for Contractor-supplied equipment warranty requirements.

12 **PART 2 – PRODUCTS**

13 **2.01 GENERAL**

14 A. The section specifies the requirements for DIN rail mounted type of PLCs.

15 B. Design programmable logic controller (PLC) to accept input contact and analog signals,
16 perform the functions specified, and output contact and analog signals to control and/or
17 indicate the specified processes.

18 C. Provide DIN rail-mounted style PLC consisting of I/O racks, power supplies, CPUs,
19 memory units, network communication modules, and I/O modules:

20 1. Provide a modular type system with the necessary number and type of inputs and
21 outputs:

22 a. Noise immunity to meet NEMA Standard ICS2-230.

23 2. Provide expansion cables and power supplies at each location as required.

24 3. DIN rail mounted PLC shall fit within the space provided in the existing panels and as
25 shown on the new panel Drawings.

26 **2.02 DIN RAIL MOUNTED PLC**

27 A. Common Hardware Ratings:

28 1. Operating Temperature Range: 0°C to +55°C.

29 2. Storage Temperature Range: -40°C to +85°C.

- 1 3. Humidity Range: 5% to 95% noncondensing.
- 2 4. Noise Immunity in compliance to NEMA Standard ICS 2-230.
- 3 5. Operation Vibration Rating: 5.0 G at 10 to 500 Hz, 0.030-inch peak-to-peak.
- 4 6. Isolation Level: 1500 V between backplane and I/O.
- 5 7. Dielectric Withstand Rating: 1500 VAC in compliance with UL 508, CSA C22.2
- 6 No. 142.

7 B. Processor Unit:

- 8 1. Program Memory: 2 MB RAM, minimum.
- 9 2. Capable of controlling up to 16 I/O modules.
- 10 3. Online programming including runtime editing.
- 11 4. Standard RAM memory back-up provided through minimum 2-year lithium battery.
- 12 5. Memory card: Industrial SD card, 2 GB maximum.
- 13 6. LED indicators for: RUN, FORCE, I/O, OK, NS, LINK 1, LINK 2, SD.
- 14 7. Three Communication Ports:
 - 15 a. Two Ethernet ports that support Ethernet/IP protocol.
 - 16 b. One USB.
- 17 8. Real-time clock.
- 18 9. Acceptable Manufacturer:
 - 19 a. Allen-Bradley:
 - 20 1) CompactLogix 5069-L320ER.
 - 21 b. No substitutions.

22 C. Discrete Input Modules:

- 23 1. Operating Voltage: 24 VDC.
- 24 2. Sixteen non-isolated inputs or eight isolated inputs as required.
- 25 3. LEDs to indicate the status of each I/O point.

- 1 4. Acceptable manufacturer for 16 non-isolated inputs:
- 2 a. Allen-Bradley 5069-IB16.
- 3 b. No substitutions.
- 4 D. Analog Input Modules:
- 5 1. Eight input channels per module.
- 6 2. Ratings:
- 7 a. Current Rating: 0 to 20 mAdc, 4 to 20 mAdc.
- 8 b. Voltage Rating: Plus/Minus 10 VDC, 0 to 10 VDC, 0 to 5 VDC, 1 to 5 VDC.
- 9 3. Terminal Impedance:
- 10 a. Current Rating: 250 ohms.
- 11 b. Voltage Rating: 220 K ohms.
- 12 4. LEDs to indicate the status of each I/O point.
- 13 5. Acceptable Manufacturer:
- 14 a. Allen-Bradley 5069-IF8.
- 15 b. No substitutions.
- 16 E. Relay Output Modules:
- 17 1. Voltage Rating: 5 to 125 VDC.
- 18 2. Eight relay outputs.
- 19 3. Continuous Current Rating per Point: 2.5 AAC not to exceed 1440 VA for the module.
- 20 4. Continuous Current Rating per Module: 16 AAC, 2.5 A/common.
- 21 5. LEDs to indicate the status of each I/O point.
- 22 6. Acceptable Manufacturer:
- 23 a. Allen-Bradley 5069-OB8.
- 24 b. No substitutions.
- 25 F. Provide taps and cables as required for connecting PLC to related devices.
- 26 G. CompactLogix devices shall be 5069 Modular CompactLogix Controller compatible.

1 **2.03 NAMEPLATE**

- 2 A. Refer to Section 26 05 53 for nameplate information requirements.

3 **PART 3 – EXECUTION**

4 **3.01 INSTALLATION**

- 5 A. Install PLC in accordance with manufacturer's recommendations and as required to
6 provide complete and fully functional systems.
- 7 B. Install equipment in configuration shown in Drawings.
- 8 C. Install I/O connections in configuration shown in Drawings and in the I/O list per
9 Section 40 61 93.
- 10 D. Install component identification and wire tags on all wiring.
- 11 E. Hardware System Integrator shall work with the Software System Integrator to ensure PLC
12 system including the I/O is properly working.

13 **3.02 TESTING AND COMMISSIONING**

- 14 A. Testing shall include visual verification of enclosure, disconnect device, fused isolation
15 transformers, terminal blocks, wiring ducts, suppression devices, etc.
- 16 B. Verify PLC and enclosure is bonded to equipment rack or building grounding system.
- 17 C. Verify that all connections between PLC and devices are complete.
- 18 D. Verify that all incoming power supply matches the voltage setting for the PLC.
- 19 E. Verify that all protective devices are set to their appropriate trip settings.
- 20 F. Verify that all input/output devices are connected to the correct input/output points and
21 giving the correct signals.
- 22 G. Input devices can be manipulated to give the open and closed contact conditions and LED
23 on the input module is observed. I/O shall also be confirmed at the HMI.
- 24 H. Verify that loading (transferring) and testing the software operates correctly.
- 25 I. Verify panel UPS units provides power to PLC system equipment during a utility power
26 outage.
- 27 J. Submit a PLC system test report including I/O commissioning test report. Test report shall
28 be signed as completed by both the hardware integrator and software programmer.

29 **3.03 HOUSEKEEPING**

- 30 A. Use cable management to secure cables in PLC control cabinet.

- 1 B. Clean units as recommended by manufacturer.
- 2 C. Redline the construction drawings to show changes made during the construction. Submit
- 3 redline drawings to Owner for preparation of record drawings.

4 **3.04 TRAINING**

- 5 A. The Contractor's Software System Integrator shall provide one-half day of training for the
- 6 PLC hardware. This training shall demonstrate the manufacturer's specific requirements
- 7 for installation, operation and maintenance. Refer to Section 40 68 13.

8 **END OF SECTION**

1 **SECTION 40 66 00**

2 **NETWORK AND COMMUNICATION EQUIPMENT**

3 **PART 1 – GENERAL**

4 **1.01 SUMMARY**

- 5 A. This section specifies the requirements and functions of the network and communication
6 equipment and hardware as shown on the Drawings.
- 7 B. Contractor shall provide network and communication equipment and hardware as shown on
8 the Drawings, as specified herein, and as needed for a complete and proper installation.
- 9 C. Related Work: Documents affecting work under this section includes, but is not necessarily
10 limited to CSI Divisions 26 and 40.
- 11 D. Work under this section includes:
- 12 1. Providing network equipment.
- 13 2. Start-up and testing of the network equipment.

14 **1.02 SUBMITTALS**

- 15 A. Submittal Procedures: Section 26 05 11, "Basic Electrical Methods and Materials."
- 16 B. Submit seismic anchorage hardware and installation details.
- 17 C. Submit product data for the following:
- 18 1. Ethernet Switches.
- 19 2. Cellular Remote Telemetry Unit (RTU).
- 20 D. Submit electronic copies of final equipment configurations (including passwords) after
21 Substantial Completion on four USB Flash Drives.
- 22 E. Operation and Maintenance manuals.
- 23 F. Submit a Network Communication Equipment Testing and Commissioning Plan to Owner
24 and engineering 20 days prior to testing and commissioning.
- 25 G. Submit a Network Communication Equipment report signed by both the hardware
26 integrator and software programmer within 10 days of completing the testing and
27 commissioning.

28 **1.03 ENVIRONMENTAL REQUIREMENTS**

- 29 A. Conform to sections of CS Division 26 and CSI Division 40 during and after installation of
30 the control and monitoring systems.

1 B. Maintain area, including enclosures, free of dirt and dust during and after installation of
2 products.

3 **1.04 QUALITY ASSURANCE**

4 A. Provide enclosures, devices, components, etc., which have been listed and labeled by
5 Underwriter's Laboratories.

6 B. Equipment to be provided and installed by a business that supplies and installs/configures
7 this equipment on a daily basis for the last 3 years.

8 **1.05 DELIVERY, STORAGE, AND HANDLING**

9 A. Provide conditioned storage for equipment and materials per manufacturer's requirements
10 that will become part of the completed facility so that it is protected from weather, dust,
11 water, or construction operations.

12 **1.06 WARRANTY**

13 A. Refer to Section 40 61 13 for Contractor-supplied equipment warranty requirements.

14 **PART 2 – PRODUCTS**

15 **2.01 GENERAL**

16 A. Provide the same make and model of all equipment and components which serve the
17 same function within process control panels.

18 B. Comply with applicable sections in CSI Divisions 26 and 40 for equipment supplied under
19 this section.

20 C. Provide network communications equipment for the pump control panel PCP-01,
21 consisting of but not limited to the following as applicable and as shown on the Drawings:

22 1. Provide the following equipment:

23 a. Ethernet Switches.

24 b. Cellular RTUs.

25 c. Network Accessories.

26 **2.02 ETHERNET SWITCHES**

27 A. General:

28 1. Provide switches from a single manufacturer.

29 2. Manufacturers:

30 a. MOXA.

- 1 b. Approved equal.
- 2 B. Unmanaged Switch:
- 3 1. Pluggable terminal blocks.
- 4 2. DIN rail mounting.
- 5 3. 100 Mbps connectivity, minimum.
- 6 4. 8 RJ-45 ports, minimum.
- 7 5. 1 SFP port, minimum, full duplex mode.
- 8 6. Voltage Input: 24 VDC.
- 9 7. Temperature Rating: 0°C to 75°C.
- 10 8. Model: EDS-G308 Series.

11 **2.03 CELLULAR REMOTE TELEMETRY UNITS**

- 12 A. General:
- 13 1. Provide radios from a single manufacturer.
- 14 2. Manufacturers:
- 15 a. Mission M150.
- 16 b. Approved equal.
- 17 B. RTU:
- 18 1. Data Cellular Radio:
- 19 a. Communicate with central server location via cellular radio transmitting data
- 20 through Transmission Control Protocol (TCP) socket connection.
- 21 2. Enclosure: Type 1.
- 22 3. Power: UL Recognized 120 VAC to 12 VAC transformer.
- 23 a. 12 VDC Battery Backup.
- 24 4. Digital Inputs: Eight (8) 24 VDC.
- 25 5. Analog Inputs: Two (2) 4-20 mA.

1 **2.04 NETWORK ACCESSORIES**

2 A. Cable Management:

- 3 1. Provide vertical and horizontal cable management for entire enclosure.
- 4 2. Size cable management to handle a quantity of cable greater than or equal to double
- 5 of the existing cabling.

6 B. Patch Cables (quantities as required):

- 7 1. Ethernet:
- 8 a. CAT5e.
- 9 b. Snagless molded connector.
- 10 c. Length as required.

11 **2.05 NAMEPLATE**

- 12 A. Section 26 05 53 for nameplate information requirements.

13 **PART 3 – EXECUTION**

14 **3.01 INSTALLATION**

- 15 A. Install equipment as shown in Drawings and in accordance with manufacturer's
- 16 requirements.
- 17 B. Connection to the Tribal network shall be overseen and scheduled with the Tribes' Network
- 18 Administrator. The Tribes will provide notice of 2 weeks.
- 19 C. Hardware integrator shall work with the PLC software programmer to ensure the Network
- 20 communications system is properly working.
- 21 D. Touch-up and clean enclosures after the start-up and commissioning.

22 **3.02 START-UP, TESTING, AND COMMISSIONING**

- 23 A. Start-up and testing are the responsibility of the HSI.
- 24 B. Verify electrical connections per the Contract Drawings and panel drawings submitted by
- 25 the HSI.
- 26 C. Verify equipment indicating LED annunciators are indicating proper operations.
- 27 D. Verify booster pump station and upper reservoir network communications.
- 28 E. Test and verify UPS provides power to Network Communication equipment during a utility
- 29 power outage and before the standby generator provides power.

- 1 F. Submit a Network Communication System commissioning test report. Test report shall be
2 signed by both the hardware integrator and software programmer.
- 3 G. Provide a minimum of two 8-hour days on site to support the start-up and testing of the
4 equipment in conjunction with the Owner's IT staff.
- 5 H. Coordinate IP ranges with Owner's IT staff.

6 **3.03 HOUSEKEEPING**

- 7 A. Use cable management to secure cables in enclosure.
- 8 B. Clean units as recommended by manufacturer.
- 9 C. Redline the construction drawings to show changes made during the construction. Submit
10 redline drawings to the Tribes for preparation of record drawings.

11 **3.04 TRAINING**

- 12 A. The Contractor's HSI shall provide one-half day of training for the Network hardware. This
13 training shall demonstrate the manufacturer's specific requirements for installation,
14 operation and maintenance. Refer to Section 40 68 13.

15 **END OF SECTION**
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- 1 4. Software System Integrator shall submit a resume of qualifications of the personnel
2 who will be assigned to this project. Ten years of experience working on pump stations
3 and sewer plant controls and instrumentation is required.

4 **PART 2 – PRODUCTS**

5 **2.01 GENERAL**

- 6 A. The SCADA software shall be Ignition.
7 B. The PLC software shall be Allen-Bradley Studio 5000, firmware version 33.
8 C. The OIT software shall be Allen-Bradley FactoryTalk View, firmware version 12.
9 D. Confirm software versions with the Owner. The SSI shall provide all software needed to
10 perform their work. The Owner is not responsible for providing software or licenses.

11 **PART 3 – EXECUTION**

12 **3.01 CONFIGURATION AND PROGRAMMING**

- 13 A. The Software System Integrator will install, configure, and program software in the SCADA
14 Server and SCADA Client PCs.
15 B. At the time of preparing this document, the Process Control Software recommended are
16 specified in this section. Prior to Contractor procurement of the Process Control Software,
17 the Contractor shall submit a list of software and consult with the Engineer, the HSI, and
18 the SSI to verify the list of software for procurement.

19 **3.02 TESTING AND COMMISSIONING**

- 20 A. The SSI shall develop and implement the following testing and commissioning test
21 procedure:
22 1. Testing of the developed Process Control Software (SSI scope of work) will be
23 performed at the same time of testing of the Process System Hardware (HSI scope of
24 work) specified in these Specifications.
25 2. Process Control Software:
26 a. Demonstrate that each network connected device installed under this Contract is
27 properly installed and functioning.
28 b. Demonstrate that the SCADA software installation executed under this Contract
29 has been installed and are functioning as intended.
30 c. Demonstrate that the SCADA software is properly communicating with each I/O
31 point on each PLC or other devices and that the field data is available at all network
32 nodes.

- 1 d. Demonstrate that all displays, trends, alarms, and reports have been configured
2 and are properly operating.
- 3 e. Demonstrate that all real-time data is being collected as historical data and is
4 accessible from PCs on the existing LAN.
- 5 f. Demonstrate that all control system configuration software is properly operating on
6 the HMI workstation, and that the final configuration files can be uploaded,
7 modified, and downloaded into the network attached control equipment.
- 8 g. Unless otherwise approved in writing, all testing shall be performed in the presence
9 of authorized Owner personnel from both the Operations and Maintenance
10 departments.
- 11 h. Test forms consisting of an itemized list of items tested and demonstrated shall be
12 prepared by the SSI for each system/system node testing prior to scheduling of
13 each test.
- 14 i. These forms shall be completed at the time of witnessed testing and signed by
15 both the SSI and Owner personnel.
- 16 B. The SSI shall prepare a final test report and submit it to the Owner.

17 **3.03 TRAINING**

- 18 A. Up to 8 hours of training shall be provided by the SSI, as scheduled by the Owner.
- 19 B. Control systems hardware and software training shall include the PLC, HMI, UPS, and
20 instrumentation.

21 **END OF SECTION**

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1 F. Provide all Instrumentation and Control wire required for a fully functioning Instrumentation
2 and Controls System as shown on the Drawings and as specified in CSI Division 26.

3 G. Work Specified in Other Divisions:

4 1. CSI Division 26 work, including all instrumentation and controls conduit, and only that
5 wire specified in CSI Division 26. Refer to CSI Division 26 specifications for specific
6 requirements for wire, conduit, grounding, and other electrical equipment.

7 H. The Hardware Systems Integrator shall coordinate all tests and startups of all systems
8 with the Software Systems Integrator (not in this Contract).

9 I. Work excluded under CSI Division 40 (performed by Software Systems Integrator or
10 others, outside these Contract Documents):

11 1. Programming of the PLC.

12 2. Programming and integration into the Tulalip SCADA system.

13 3. Configuration of the telemetry radio based on the site requirements.

14 **1.03 REFERENCE STANDARDS**

15 A. American National Standard Institute (ANSI) Publications:

16 1. Y14.15a Drafting Practice.

17 2. C62.1 Surge Arrestors.

18 B. Instrumentation Society of America (ISA) Publications:

19 1. S5.4 Instrument Loop Diagrams.

20 2. S20 Specification Forms for Process Measurement and Control
21 Instruments, Primary Elements and Control Valves.

22 **1.04 I&C SUBCONTRACTOR QUALIFICATIONS**

23 A. An I&C subcontractor has demonstrated experience in purchasing, calibrating, fabricating,
24 installing, and testing the Instrumentation and Control (I&C) products listed in this
25 specification section. Normally, the I&C subcontractor is a systems house regularly
26 engaged in the business of panel fabrication, control component procurement,
27 programmable logic controller and personal computer (PC) application in the process
28 control industry.

29 B. The I&C subcontractor must have at least 5 years of experience in performing all aspects
30 of the type of work specified in this section and shown on the Drawings.

1 **1.05 I&C SUBCONTRACTOR SYSTEM RESPONSIBILITIES**

- 2 A. General: The I&C equipment as specified in this division shall be considered an integrated
3 system. Entire system installation including calibration, verification, startup, operation
4 testing, and training shall be performed by qualified personnel, possessing all the
5 necessary skills and equipment, and who have had experience performing similar
6 installations. Instrumentation and control systems drawings are diagrammatic only; it is
7 the responsibility of the Contractor to obtain technical data, determine performance
8 requirements, develop instrumentation detail installation designs, and coordinate the
9 selection of specified equipment with Contractor supplied equipment to meet the design
10 conditions stated.
- 11 B. System Responsibilities:
- 12 1. Instrumentation and control system drawings are diagrammatic only. Obtain technical
13 data, determine performance requirements, develop installation details and integrate
14 I&C subcontractor supplied equipment with Contractor supplied and existing
15 equipment where depicted on the Drawings.
- 16 2. Compatibility: See that all components of the instrumentation system, including
17 equipment specified under other divisions, are completely compatible and function
18 properly as a system. Provide such additional equipment, accessories, etc., as are
19 necessary to meet these objectives at no cost to the Owner.
- 20 3. Coordination: For control components, devices, and systems specified in other
21 divisions or shown on the Drawings:
- 22 a. Provide technical advice to and electrical contractors as necessary regarding
23 installation of instruments.
- 24 b. Verify the correctness of installation of all instruments.
- 25 c. Verify that the proper type, size, and number of control wires are provided with the
26 conduits.
- 27 d. Verify that proper electric power circuits provided for all components and systems.
- 28 e. Resolve all manufacturers' installation discrepancies between requirements and
29 the detail requirements of the Drawings and Specifications.
- 30 f. Supervise final signal connections, both electric and optical, to all process
31 instrumentation and control equipment.
- 32 g. Adjust, startup, and test all process instrumentation and control equipment.
- 33 h. Provide specified documentation and training.
- 34 4. Performance: While the Drawings provide sufficient information to establish the form
35 and function of the systems and how these systems are related, the responsibility for
36 system integration and performance rests solely with the Contractor. The Engineer
37 provides technical instruction and guidance where needed.

- 1 5. Site and Instrument Inspection: Inspect site for conformance to Drawings, paying
2 special attention to space allocation and dimensions shown or required on
3 Drawings. Inspect completed work and verify that it is ready for installation of
4 instruments and equipment. Inspect each instrument and piece of equipment for
5 damage, defects, completeness, and correct operation before installing.
- 6 6. Field-modified control panels shall be field inspected and labeled by an accredited
7 engineer approved by the Washington State Department of Labor and Industries.

8 **1.06 SUBMITTALS**

9 A. Refer to Special Provisions and Section 26 05 11 for required method of preparation and
10 transmittal and conform to requirements herein.

- 11 1. The Contractor shall furnish to the Engineer for review one complete submittal package
12 including all bid items and materials necessary to complete that item of work.
- 13 2. Upon request to Owner, long lead items may be provided in a separate submittal to
14 facilitate project schedule.

15 B. Shop Drawings:

- 16 1. Drawings provided in the Contract shall be used for manufacture of the Pump Station
17 control and power panels.
- 18 2. Any required deviations for UL compliance shall be noted on the Drawings as redlines.
- 19 3. Major panel layout deviations shall be submitted to and approved by the Engineer prior
20 to manufacture of the panel.
- 21 4. Deviations of the assigned I/O points shall be submitted to and approved by the
22 Engineer prior to manufacture of the panel.
- 23 5. All equipment listed in the Bill of Material (BOM) is listed by manufacturer part/model.
24 Any substitutions shall be submitted and approved by the Engineer prior to purchase
25 and manufacture of the panel.

26 C. Record Drawings: Submit a revised set of shop drawings that incorporates all change
27 orders and modifications made during performance of the work. In addition to interconnect
28 diagrams, and elementary diagrams, submit equipment and device wiring diagrams and
29 other drawings as necessary to depict the "as-built" condition of equipment. Include all
30 installed field and panel conduit and piping/tubing runs and routing, supports, mounting
31 details, interconnection diagrams with cable, wire, tube, and termination numbers.
32 Coordinate all drawings with the conductor identification requirements in Section 26 05 53.
33 Submit a copy of produced drawings in Adobe Acrobat (PDF) format.

34 D. Operation and Maintenance Manuals: Furnish Operation and Maintenance Manuals
35 (Manufacturer cut sheets and sales brochures are not acceptable as O&M manuals),
36 including Instruction Manuals and Part Lists, for equipment provided under CSI Division 40
37 as required by Special Provisions. Obtain data from manufacturers, and format and bind
38 as specified. Obtain distribution method instructions from the Owner or his representative.

- 1 1. Schedule: Deliver at least two copies of manuals in three-ring binders (8-1/2 by 11-
2 inch format) not later than the equipment shipment date.
- 3 2. Contents: Include in manuals not less than the following information, as applicable, for
4 each instrument, equipment, subsystem and/or control loop:
 - 5 a. General, introduction and overall description, purpose, functions, simplified theory
6 of operations, etc.
 - 7 b. Specifications (including equipment specification data sheet as described above
8 under shop drawings), sufficiently detailed for reordering exact duplicates of the
9 original items.
 - 10 c. Installation instructions, procedures, sequences, tolerances, and precautions.
 - 11 d. Operational procedures.
 - 12 e. Shutdown procedures.
 - 13 f. Maintenance, calibration, and repair instructions.
 - 14 g. Parts list and spare parts recommendations.
 - 15 h. Calibration curves, rating tables, and any other data showing the relationship of
16 the variable inputs and the calibrated output of all measuring devices and
17 controlled equipment.
- 18 3. Format:
 - 19 a. Use drawings and pictorials to illustrate the text to the extent necessary to ensure
20 a clear, concise presentation. If manuals have been written to cover a family of
21 similar instruments or equipment, strike out inapplicable information in a neat
22 fashion or emphasize applicable portion by heavily weighted arrows, circles, or
23 boxes; whichever provides the clearest and neatest presentation.
 - 24 b. Group manuals by system control panels, including field instrumentation
25 connected or associated with the panel. Where identical instruments are used
26 in more than one control loop or subsystem, include only one instruction manual,
27 per panel grouping; however, an index by tag number for all instruments shall
28 identify its location in that manual.
 - 29 c. Provide control loop and/or subsystem operational descriptions to identify the
30 function of each instrument and its relation to the other instruments in the loop.
- 31 4. Binding: Bind each manual in a cover which indicates the panel or process area to which
32 it applies, manufacturer's name, local address and telephone number, and year of
33 purchase. Punch and bind manuals in standard three ring binders and include system
34 name and subcontractor's name on binding.

35 E. Accessory and Maintenance Materials: Submit data for the following items:

- 1 1. Special Tools and Accessories: Special tools, instruments, and accessories for
2 maintaining instruments and equipment requiring periodic repair and adjustment as
3 specified elsewhere herein. Also, furnish special lifting and handling devices for
4 equipment requiring such devices.
- 5 2. Maintenance Materials and Spare Parts: Submit a list of manufacturers recommended
6 spare parts for each item specified. Refer to other sections of these Specifications.
- 7 F. Test Reports: Submit the following test reports as described herein:
- 8 1. Instrument Calibration Data Sheets (paragraph 2.12).
- 9 2. Factory Testing of Control Panels (paragraph 2.13).
- 10 G. Demonstration and Final Operation Test Plan and Results: Submit a document that
11 outlines all procedures to be used in final operational testing of instrument and control
12 systems. Include a description of each system, the scope of testing, test methods and
13 materials, testing instruments and recorders, a list of functional parameters to be recorded
14 on each item, and marked up Contract Drawings showing temporary bypasses, jumpers,
15 and devices. Include two columns for the Tribe's Software System Integrator for PLC and
16 SCADA check off for all I/O new and existing.

17 **1.07 QUALITY ASSURANCE**

- 18 A. Standard of Quality: The Contractor shall provide equipment of the types and sizes
19 specified which has been demonstrated to operate successfully. Provide equipment which
20 is new and of recent proven design.

21 **1.08 DRAWINGS**

- 22 A. Drawings: The Instrumentation Drawings are diagrammatic; exact locations of
23 instrumentation products shall be determined in the field by the Engineer. Except where
24 special details are used to illustrate the method of installation of a particular piece or type
25 of equipment or material, the requirements or descriptions in this Specification shall take
26 precedence in the event of conflict.

- 27 1. Locations of equipment, inserts, anchors, motors, panels, pull boxes, manholes,
28 conduits, stub-ups, fittings, power and convenience outlets, and ground wells are
29 approximate unless dimensioned; verify locations with the Engineer prior to
30 installation. Field verify scaled dimensions on Drawings.

- 31 2. Review the Drawings and Specification Divisions of other trades and perform the
32 instrumentation work that will be required for the installations.

- 33 3. Should there be a need to deviate from the Instrumentation Drawings and
34 Specifications, submit written details and reasons for all changes to the Engineer for
35 favorable review.

- 36 4. The Drawings provide details of installation and supersede the manufacturer's
37 recommendation where a conflict exists.

1 **1.09 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- 2 A. Box, crate, or otherwise enclose and protect instruments and equipment during shipment,
3 handling, and storage. Keep all equipment dry and covered from exposure to weather,
4 moisture, corrosive liquids and gases or any element that could degrade the equipment.
5 Protect painted surfaces against impact, abrasion, discoloration, and other damage. Notify
6 the Engineer in writing in the event that any equipment or material is damaged. Obtain
7 prior favorable review by the Engineer before making repairs to or replacement of
8 damaged products.

9 **PART 2 – PRODUCTS**

10 **2.01 MATERIALS AND STANDARD SPECIFICATIONS**

- 11 A. Provide instruments, equipment, and materials suitable for service conditions and meeting
12 standard specifications such as ANSI, ASTM International (ASTM), ISA, and SAMA. The
13 intent of this Specification is to secure instruments and equipment of a uniform quality and
14 manufacture throughout the plant. All instruments in the plant of the same type shall be
15 made by the same manufacturer.

16 **2.02 NAMEPLATES**

- 17 A. For each piece of equipment, provide a manufacturer's nameplate showing his name,
18 location, the pertinent ratings, and the model designation.
- 19 B. Identify each piece of equipment and related controls with a rigid laminated engraved
20 phenolic nameplate. Engrave nameplates with the inscriptions indicated on the Drawings
21 and, if not so indicated, with the equipment name. Securely fasten nameplates in place
22 using two stainless steel screws. Where no inscription is indicated on the Drawings,
23 furnish nameplates with an appropriate inscription furnished by the Engineer upon prior
24 request by the Contractor.
- 25 C. Each control device, including pushbuttons, control switches, and indicating lights, shall
26 have an integral legend plate or nameplate indicating the device function. These shall be
27 inscribed as indicated on the Drawings or as favorably reviewed by the Engineer.
- 28 D. Provide CAUTION or SAFETY nameplates to alert operators of special conditions that
29 may result in faulty equipment operations or locations where differing voltages may
30 require special attention or PPE. Devices containing batteries that must be replaced
31 periodically must be clearly identified. Nameplates are not required if the device senses
32 and displays a low battery warning.

33 **2.03 EQUIPMENT NAME TAGS**

- 34 A. All instrumentation and equipment items or systems shall be identified by name tags. Field
35 equipment shall be tagged with the assigned instrumentation tag number listed on the
36 Drawings.
- 37 B. Name tags shall be stainless steel with engraved or stamped black characters of 3/16-inch
38 minimum height. Tags shall be attached to equipment with a tag holder and stainless-steel

1 band with a worm screw clamping device. Use 20-gauge stainless steel wire where banding
2 is impractical. For field panels or large equipment cases use stainless steel screws;
3 however, such permanent attachment shall not be on an ordinarily replaceable part.

4 **2.04 FIELD-MOUNTED EQUIPMENT**

5 A. All instrument and control equipment mounted outside of protective structures shall be
6 equipped with suitable surge arresting devices to protect the equipment from damage due
7 to electrical transients induced in the interconnecting lines from lightning discharges or
8 nearby electrical devices. Protective devices used on 120 VAC inputs to field mounted
9 equipment shall be secondary valve surge protectors conforming to the requirements of
10 ANSI C62.1.

11 **2.05 EQUIPMENT OPERATING CONDITIONS**

12 A. All equipment shall be rated for normal operating performance with varying operating
13 conditions over the following minimum ranges:

14 1. Electrical Power: 120 VAC \pm 10%, 60 Hz, unregulated, except where specifically stated
15 otherwise on the Drawings or in the Specifications, or when two-wire, loop-powered
16 devices are specified.

17 2. Field Instruments:

18 a. Outdoor Areas:

19 1) Ambient Temperature: -10°F to +120°F.

20 2) Ambient Relative Humidity: 5% to 100%.

21 3) Weather: Rain and sleet.

22 b. Indoor Areas:

23 1) Ambient Temperature: +35°F to +120°F.

24 2) Ambient Relative Humidity: 5% to 95% non-condensing.

25 **2.06 EQUIPMENT LOCATIONS**

26 A. Provide equipment and materials suitable for the types of locations as defined under CSI
27 Division 26. All equipment specified for field mounting shall be weatherproof and splash
28 proof as a minimum. If electrical or electronic components are contained within the
29 equipment, these items shall be housed in NEMA 3R gasketed cases, and NEMA 4X in
30 corrosive locations unless noted otherwise on the Drawings or specific item specification.

31 **2.07 ANALOG SIGNAL INDICATED UNITS**

32 A. For all instruments with local or remote indicators, provide indicators scaled in actual
33 engineering units, i.e., gallons per minute, feet, psi, etc., rather than 0 to 100%, unless
34 noted otherwise on the Drawings or Instrument Index.

1 **2.12 FACTORY TESTING OF CONTROL PANELS**

- 2 A. All fabricated equipment shall be tested before it leaves the factory. At the factory verify
3 wiring continuity and equipment operation by simulating input and output.
- 4 B. Factory testing of control panels/devices/equipment shall be accomplished. Refer to
5 individual specification sections for tests requiring favorable review.
- 6 C. Upon completion of factory testing, submit a report certifying the control
7 panels/devices/equipment are operable and meet the Specifications.
- 8 D. A UL 508 label shall be affixed to the control panel door prior to shipment.

9 **PART 3 – EXECUTION**

10 **3.01 MOUNTINGS**

- 11 A. Mount and install equipment as indicated. Mount field instruments on pipe mounts or other
12 similar means in accordance with suppliers' recommendation. Where mounted in control
13 panels, mount according to requirements of that section.
- 14 B. Equipment specified for field mounting shall be suitable for direct pipe mounting or surface
15 mounting, surface-mounted indicators and equipment with calibration adjustments or
16 requiring periodic inspection shall be mounted not lower than 3 feet 6 inches nor higher
17 than 6 feet above walkways, platforms, catwalks, and the like.
- 18 C. Note that applicable specifications require detail drawings showing anchorage
19 requirements for the equipment. Anchorage requirements are specified in CSI Division 3.
- 20 D. All devices shall be accessible to operators for servicing, operating, reading, etc. Provide
21 permanent platforms to ensure devices are continuously accessible.

22 **3.02 FIELD WIRING**

- 23 A. Ring out signal wiring prior to termination and perform surge withstand tests where
24 required (see Section 26 05 11, NETA testing requirements). Verify wire number and
25 terminations are satisfactory as designated on the Loop and Interconnect Diagrams. Verify
26 all terminations are tight and shields are uniformly grounded at one location.

27 **3.03 ELECTROMAGNETIC INTERFERENCE (EMI)**

- 28 A. Construction shall proceed in a manner which minimizes the introduction of noise
29 (RFI/EMI) into the I&C System.
- 30 B. Cross signal wires and wires carrying ac power or control signals at right angles.
- 31 C. Separate signal wires from wires carrying ac power or switched ac/dc control signals within
32 control panels, terminal cabinets, telemetry equipment, multiplexer cabinets, and data
33 loggers as much as possible.

1 **3.04 SIGNAL GROUNDING**

2 A. A single-point grounding system for instrument signals is required for all instrument panels.
3 This instrument single point grounding system does not use building steel or conduit
4 systems for its ground path:

5 1. Ground all signal shields, signal grounds, and power supplies at an isolated signal bus
6 within each instrument panel, rack, or enclosure. The shields at the far ends of these
7 signal cables must be disconnected (floated) from any ground to prevent ground loops.

8 2. Do not connect the rack or enclosure frames to the signal grounding buses.

9 3. Connect each isolated signal ground bus within each panel using a stranded, insulated
10 copper wire of size 6 AWG or larger directly to a system ground rod installed per the
11 Drawings.

12 B. If more than one instrument panel or rack is installed side-by-side, locate an isolated
13 system grounding plate in one of the panels:

14 1. Connect all the isolated signal buses in such instrument panel or rack radially to the
15 system ground plate using a stranded, insulated copper wire of size 8 AWG or larger.

16 2. Do not use conduit, cable raceways or building steel to distribute the grounding
17 connections; use dedicated wires as specified above. Install a single conduit
18 containing a #2 AWG insulated ground wire from the insulated grounding plate directly
19 to a system ground rod installed per the Drawings. See CSI Division 26 for conduit
20 requirements.

21 **3.05 PREPARATION**

22 A. Ensure that installation areas are clean and that concrete or masonry operations are
23 completed prior to installing instruments and equipment. Maintain the areas in a broom-
24 clean condition during installation operations.

25 B. Panels shall be protected during construction to prevent damage to front panel devices
26 and prevent dust accumulation in the intervals. Other protective measures (lamp, strip
27 heaters, etc.) shall be included as weather conditions dictate.

28 **3.06 FIELD TESTING**

29 A. General: The purpose of the field testing is to verify instruments are calibrated and
30 operationally performing the intended function. Provide the services of factory trained and
31 experienced engineers to perform verification and operational testing as prescribed below.
32 Since the initial calibration of instruments may not satisfy the final operation of system,
33 perform recalibration or adjust setpoints as required to satisfy the performance
34 requirements of the system. Notify the Engineer in writing a minimum of 48 hours prior to
35 the proposed date for commencing final operational testing and acceptance. Coordinate
36 with the Tribe's Software System Integrator for all testing to be performed.

37 B. System Verification Testing: Verify that each instrument is operating and calibrated by
38 simulating inputs at the primary element in each system loop and verify performance at

- 1 loop output devices (i.e. recorder, indicator, alarm, etc., except controllers). Simulate
2 inputs at 0%, 25%, 50%, 75%, and 100% of span or with on-off inputs, as applicable.
3 During system verification:
- 4 1. Make initial or provisional settings on levels, alarms, etc.
 - 5 2. Verify controllers by observing that the final control element moves in the proper
6 direction to correct the process variable as compared to the set point.
 - 7 3. Cause malfunctions to sound alarms or switch to standby to check system operation.
 - 8 4. Check all loop instruments thoroughly for correct operation.
 - 9 5. Immediately correct all defects and malfunctions disclosed by tests.
 - 10 6. Submit a report certifying completion of verification of each instrument system. This
11 report shall include a data sheet on each instrument tested that indicates instrument
12 tolerances, instrument calibration verification, data, and initial settings made to
13 devices.
- 14 C. Final Operational Testing: Upon completion of instrument verification, test all systems
15 under process conditions in the presence of the Owner or designated representative.
16 System testing shall be accomplished in accordance with an approved Test Plan. The test
17 for each portion thereof shall be witnessed, documented, and signed off upon completion
18 by the Engineer. The intent of this test is to demonstrate and certify the operational
19 interrelationship of plant instrumentation and control systems. This testing shall include,
20 but not be limited to:
- 21 1. Making final adjustments to levels, alarms, etc.
 - 22 2. Optimum tuning of controllers.
 - 23 3. Checking all alarms, failure interlocks, and operational interlocks.
 - 24 4. Coordination with the Tribe's Software System Integrator for verifying all computer
25 input and outputs and computer monitors are fully functional.
 - 26 5. Immediately correcting all defects and malfunctions and retesting.
 - 27 6. Submit the witnessed test results and a transmittal letter indicating that all required
28 systems have been tested satisfactorily and the systems meet all the functional
29 requirements of the applicable specifications.

30 **3.07 INSTRUCTION OF OWNER'S PERSONNEL**

- 31 A. Provide the services of a factory trained and field experienced instrumentation engineer
32 to conduct group training of the Owner's designated personnel in the operation of each
33 instrument system. This training shall be for the time period of up to five working days and
34 shall be performed during the operational testing period. Include instruction covering basic
35 system theory, operating principles and adjustments, routine maintenance and repair, and

1 "hands on" operation. The text for this training shall be the Operation and Maintenance
2 Manuals furnished under these Specifications.

3 **END OF SECTION**
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SECTION 40 70 00.01

INSTRUMENTATION SCHEDULE

I/O Tag	Sheet	Type	Provided By	Specification	Type	Notes
FIT-001		AI	Contractor	40 71 10	Flow Transmitter	See Drawings for location
LSHH-001		DI	Contractor	40 71 20	Level Switch	See Drawings for location
LSH-001		DI	Contractor	40 71 20	Level Switch	See Drawings for location
LSL-001		DI	Contractor	40 71 20	Level Switch	See Drawings for location
LSLL-001		DI	Contractor	40 71 20	Level Switch	See Drawings for location
ZS-001		DI	Contractor	40 78 00	Intrusion Switch	See Drawings for location
ZS-002		DI	Contractor	40 78 00	Intrusion Switch	See Drawings for location

4

Notes: FIT = FLOW INDICATING TRANSMITTER LSL(L) = Level Switch Low (Low) LSH(H) = Level Switch High (High) AI = Analog Input DI = Discrete Input

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END OF SECTION

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- 1 C. Accuracy: System accuracy shall be within $\pm 1\%$ of actual flow rate over a fluid velocity
2 range of 1 to 30 feet per second (fps), and within 0.01 fps for velocities less than 1 fps.
3 Repeatability shall be 0.1% of full scale or better. System accuracy shall be traceable to
4 NIST using prototype meters of the same configuration.
- 5 D. Parts: Flow tube and element, transmitter, interconnecting cables, mounting hardware,
6 and calibrator.

7 **1.07 SERVICE**

- 8 A. Process Liquid: Wastewater. - Organic solids in aqueous suspension, 0% to 3% by weight,
9 some organic grease, varying amounts of abrasive grit, over and ambient temperature
10 range of -10°F to +120°F and a process temperature range of +15°F to +120°F.
- 11 B. Electrical Classification: Class I, Group D, Division 2.
- 12 C. Testing Laboratory Approval: Major electrical components (i.e., flow tube/flow element and
13 indicator/transmitter) shall be approved and labeled by an acceptable electrical testing
14 laboratory, either UL, CSAUS, NRTL, or FM for Class I, Group D, Division 2.

15 **PART 2 – PRODUCTS**

16 **2.01 MANUFACTURERS**

- 17 A. Manufacturers and equipment shall be according to the following list, unless otherwise
18 approved by the Owner's representative:
- 19 1. Sitrans FM MAG 5100W with remote panel mounted MAG 5000 transmitter and
20 display.

21 **2.02 FEATURES**

- 22 A. Zero stability feature to eliminate the need to stop flow to check zero alignment.
- 23 B. No obstructions to flow.
- 24 C. If an empty pipe is detected, signal shall be automatically reset to zero and resume
25 operation upon restored flow. Also, allow a signal from the PLC to reset to zero.

26 **2.03 PROCESS CONNECTION**

- 27 A. Meter Size: As indicated on the Drawings.
- 28 B. Connection Type: ASME B15.5 class 150 flanges.
- 29 C. Flange Material: Carbon steel.

1 **2.04 SIGNAL INTERFACES**

- 2 A. Output signal shall be 4 to 20 mA DC.
- 3 B. Scaled pulse output.
- 4 C. Hart protocol, permitting digital communication and calibration over same 2-wire cable as
5 4 to 20 mA output signal.

6 **2.05 POWER**

- 7 A. 120 V, unless otherwise noted.

8 **2.06 ELEMENT**

- 9 A. Flow Tube/Flow Element.
- 10 1. Tube Material: Carbon steel ASTM A 105 with corrosion protection EN ISO 12944
11 grade C5 (durability up to 15 years).
- 12 2. Tube Lengths: Manufacturer standard lengths.
- 13 3. Liner Material: NBR Hard Rubber.
- 14 4. Liner Protectors: Covers on each end to protect liner during shipment.
- 15 5. Electrode Material: Hastelloy C276.
- 16 6. Grounding Rings or Electrodes: Hastelloy C276. Provide grounding rings/electrodes,
17 securely mounted to ensure proper operation regardless of piping material. If
18 grounding electrodes are provided, grounding rings shall also be provided to for liner
19 protection. Provide grounding straps as required by the piping material and installed
20 with the required appurtenances as needed to connect appropriately at the flow
21 element, the associated valve vault, and the station grounding grid as recommended
22 by the manufacturer.
- 23 7. Enclosure Rating: IP68 – sensor terminations shall be potted with manufacturer potting
24 kit.
- 25 8. Flow range: 200 – 1500 gpm.

26 **2.07 INDICATOR/TRANSMITTER**

- 27 A. Display: Indicating in units of gpm and totalizing in units of gallons or gallons multiplied.
- 28 B. Mounting: remote panel mount with manufacturer wall mounting unit.
- 29 C. Enclosure: NEMA4X.
- 30 D. Zero and Span: Field adjustable.

- 1 E. Output: 4-20mA.
- 2 F. Scaled pulse output.
- 3 G. Indicator: LCD display.
- 4 H. Suitable for use with any size of element.
- 5 I. Terminations: Shall provide low power voltage to the element and shall have wiring
- 6 terminals environmentally isolated from the electronics.
- 7 J. HART protocol required.

8 **2.08 CABLES**

- 9 A. Types: As required for empty pipe detection and as recommended by manufacturer.
- 10 B. Lengths: As required for transmitters mounted directly to flow tubes. Refer to Plans.

11 **2.09 CALIBRATION SYSTEM**

12 A. Features:

- 13 1. Field programmable electronics.
- 14 2. Self-diagnostics with troubleshooting codes.
- 15 3. Ability to program electronics with full scale flow, engineering units, meter size, zero
- 16 flow cutoff, desired signal damping, totalizer unit digit value, etc.
- 17 4. Initial flow tube calibration and subsequent calibration checks.
- 18 5. Transmitter shall not require factory calibration after electrode replacement and shall
- 19 maintain the specified accuracy.

20 B. Equipment:

- 21 1. Transmitter with each flow meter provided.
- 22 2. One portable calibrator required for the electromagnetic flow meter provided.

23 **PART 3 – EXECUTION**

24 **3.01 GENERAL**

- 25 A. Work shall be performed in a workmanlike manner by craftsmen skilled in the particular
- 26 trade. All work shall present a neat and finished appearance.
- 27 B. Products shall be installed in accordance with manufacturer's written instructions.
- 28 C. Flow meter conduit entry shall be FLEX type.

- 1 D. Flow meters installed below grade shall have flow tube terminal boxes filled with factory-
2 supplied, removable two-part sealing compound for submersion protection. The
3 Contractor shall install the compound immediately after field quality control tests.
- 4 E. For any approved substitutions, it is the responsibility of the Contractor to adhere to the
5 requirements of the substituted equipment manufacturer's installation requirements and
6 these specifications. If the manufacturer's installation requirements conflict with these
7 Specifications/Drawings in such a way that may void the manufacturer's warranty, the
8 manufacturer's requirements shall prevail.

9 **3.02 FIELD QUALITY CONTROL**

10 A. Functional Test:

- 11 1. Inspect magnetic flow meters for proper installation and operation by the factory
12 supplier, with NIST traceable instrument and methods.
- 13 2. Record test data for report in accordance with Section 40 70 00. Include report in the
14 O&M manual.
- 15 3. Field parameter settings shall be provided in the O&M manual.

16 **END OF SECTION**

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1 **PART 2 – PRODUCTS**

2 **2.01 MANUFACTURERS**

3 A. Manufacturers and equipment shall be according to the following list, unless otherwise
4 approved by the Owner's representative:

5 1. Float Switches shall be Flynt – Model ENM-10.

6 **2.02 SIGNAL INTERFACES**

7 A. Float Switches shall be rated for 250 VAC at 10 A and 24 VDC at 10 mA minimum to
8 6 A maximum.

9 **2.03 FLOAT SWITCHES**

10 A. Float Casing Material: Polypropylene.

11 B. Switch: Mechanical switch (non-mercury type) in float casing, SPDT N.C., minimum
12 10 A contacts rated 120 VAC.

13 C. Bulb Shape: Pear.

14 D. Cable: NBR/PVC with sufficient length to terminate in the termination panel with 3 feet of
15 slack.

16 E. Actuation Point: Maximum angle of 20 degrees above, 10 degrees below horizontal, or
17 1 inch above/below horizontal.

18 F. Provide switch cables of suitable lengths for the individual installations. Consult the
19 Drawings for applications and ranges. The Contractor shall verify each float cable length
20 requirement and provide cable lengths with the float switch product submittal data.

21 G. Approval: ATEX/IECEX.

22 **PART 3 – EXECUTION**

23 **3.01 GENERAL**

24 A. Work shall be performed in a workmanlike manner by craftsmen skilled in the particular
25 trade. All work shall present a neat and finished appearance.

26 B. Products shall be installed in accordance with manufacturer's written instructions.

27 C. Float switches shall be installed at the elevations shown on the Drawings.

1 **3.02 FIELD QUALITY CONTROL**

2 A. Functional Test:

3 1. Inspect float switches for proper installation and operation as directed by the
4 manufacturer.

5 2. Verify and record float trip settings to within 0.2 inches by gradually raising the water
6 level in the wet well and measuring down to the water surface. Record the float switch
7 trip point and adjust as necessary to match the required levels to within 0.2 inches.

8 3. Record test data for report in accordance with Section 40 70 00. Include report in the
9 O&M manual.

10 4. Field parameter settings shall be provided in the O&M manual.

11 **END OF SECTION**

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1 **PART 2 – PRODUCTS**

2 **2.01 GENERAL**

3 A. Provide panel mounted instrumentation and control equipment of manufacturer and model
4 as specified in the Drawings.

5 B. Products shall be classified for the following locations, unless otherwise specified. Where
6 more than one of the below conditions applies, equipment shall be dual rated:

7 1. Indoor Locations: NEMA 12.

8 2. Outdoor Locations: NEMA 4X.

9 3. Corrosive Areas: Nonmetallic NEMA 4X.

10 4. Hazardous Areas: NEMA 7.

11 **2.02 CONTROL DEVICES**

12 A. Pushbuttons:

13 1. 30.5 mm flush head, heavy-duty, with NEMA rating to match enclosure type.

14 2. Operators: Red for stop functions and black for all other functions.

15 3. Provide pushbuttons designated “Lock-Out-Stop” (LOS) with a padlockable
16 attachment to maintain the device in a depressed (stop or open) position.

17 4. Escutcheon (nameplate) legend as specified on the Drawings.

18 5. Unless otherwise specified, use momentary contact type.

19 6. Contact Blocks:

20 a. NEMA ICS 2 designation A600 except when switching circuits monitored by
21 programmable controllers or other solid-state circuits.

22 b. Hermetically sealed, logic-read type.

23 c. Acceptable Manufacturer:

24 1) Siemens.

25 2) Square D.

26 3) Or approved equal.

- 1 B. Selector Switches:
- 2 1. 30.5 mm heavy-duty, with NEMA rating to match enclosure type.
- 3 2. Unless otherwise indicated, contact blocks and number of positions as required to
- 4 perform the specified operations.
- 5 3. Contact Blocks: Rated as specified in this section.
- 6 4. Escutcheon Legend: As indicated on the Drawings.
- 7 5. Acceptable Manufacturer: Where solid state loads are switched, and the indicated
- 8 contact development cannot be obtained with logic-read type contacts:
- 9 a. Siemens.
- 10 b. Square D.
- 11 c. Or approved equal.

12 C. Indicating Lights:

- 13 1. Indicating Lights: 5 to 6 VDC light emitting diodes (LEDs) with autotransformer and
- 14 push-to-test feature.
- 15 2. Testing: As a group using a common lamp test button.
- 16 3. Indicating Light Colors: Per Drawings.
- 17 4. Heavy-duty, with NEMA rated socket/wiring to match enclosure type.

18 D. Control Stations:

- 19 1. Pushbuttons: Protective Hypalon boots.
- 20 2. When indicating lights are specified, size to accommodate the transformer type lights.
- 21 3. Acceptable Manufacturer:
- 22 a. Siemens.
- 23 b. Square D.
- 24 c. Or approved equal.

25 **2.03 MAGNETIC CONTACTORS**

26 A. Lighting Contactors:

- 27 1. Electrically held contactors used to switch current to incandescent filament,
- 28 fluorescent and high intensity discharge lamp loads.

- 1 2. Rated 600 VAC, 60 Hz.
- 2 3. Coil Voltage Contact Rating and Number of Phase: As specified.
- 3 B. Motor Contactors:
- 4 1. Designed for continuous operation of induction motors at 600 V or less at 60 Hz and
- 5 comply with NEMA ICS 2-321.
- 6 2. Minimum Contactor Size: Unless otherwise indicated, NEMA size 1.
- 7 3. Supply the contactor with a normally open auxiliary contact for use as a hold-in contact
- 8 as a minimum. Provide additional contacts as indicated.
- 9 4. Additional contacts as needed.
- 10 5. The coil voltage, frequency, and number of poles to be as specified.

11 **2.04 INSTRUMENTATION**

- 12 A. Intrusion Limit Switches:
- 13 1. Pre-wired limit switches designed for control panels and hatches.
- 14 2. Snap-action, single-pole double-throw (SPDT), normally closed relay contacts.
- 15 3. Voltage input: 24 VDC.
- 16 4. Factory sealed in an IP65 enclosure.
- 17 5. UL Listed.
- 18 6. Manufacturers: Honeywell, Square D, or approved equal.

19 **PART 3 – EXECUTION**

20 **3.01 GENERAL**

- 21 A. Mount safety devices per manufacturer recommendations, locations per the Drawings.

22 **3.02 FIELD CHECKOUT AND TESTING**

- 23 A. Checkout each miscellaneous electrical device for:
- 24 1. Proper mounting.
- 25 2. Proper interconnections.
- 26 3. Absence of shorts and grounds.
- 27 4. Proper function of motor start and control equipment.

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